MACHINERY.

November, 1906.

WORKING STRENGTH OF BOLTS.

F. E. CARDULLO.

DOUBTLESS most of the readers of MACHINERY have heard of the rule in use in many drafting offices, "Use no bolts smaller than ⅝-inch diameter, unless space or weight is limited." Or perhaps they may have heard pretty much the same thing stated in another way, namely, that a man will twist off a ½-inch bolt, trying to make a steam-tight joint. It is a matter of common experience among mechanics that a bolt has to be strained up a good deal in order to make a tight packed joint, and that bolts must not only be made large enough to properly sustain the load due to the steam or water pressure, but to sustain this initial stress as well.

Bolts subject to tension are called upon for two different classes of service. Either they serve to hold two heavy and rigid flanges together, metal to metal, or they serve to compress a comparatively elastic packing, in order to make a joint steam-tight. In either case the bolt is under a considerable initial tension, due to the strain of screwing up, and hence the advisability of not making it smaller than ⅝ inch diameter. When the flanges are pressed together iron to iron, they are much more unyielding than the bolts. Hence when the bolts are screwed up, they are stretched a good deal more than the flanges are compressed. If we assume that the flanges are so heavy and unyielding that they cannot be compressed at all, the bolt is virtually a spring, and in order to produce in it a stress greater than the initial stress, we must pull so hard on the flanges as to separate them.

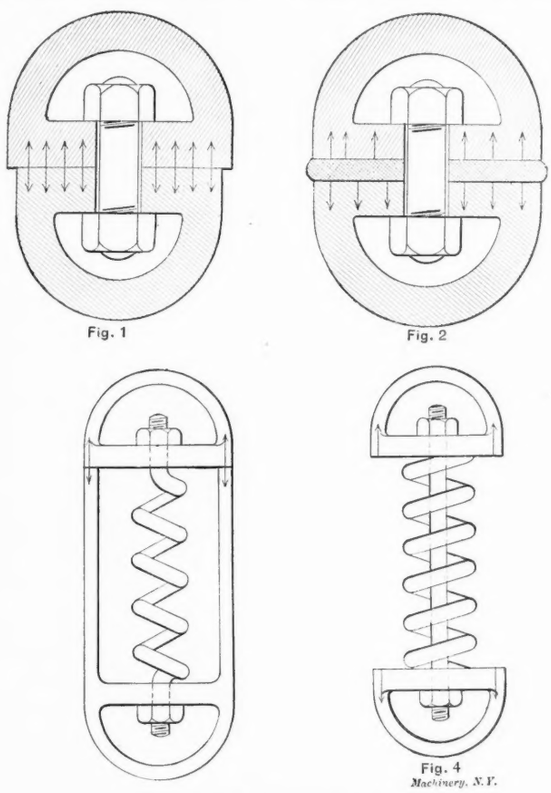

Fig. 1

Fig. 2

Fig. 4

Machinery, N.Y.

Illustrating the Stresses in Bolts.

The truth of this statement may be seen by referring to Fig. 1. The bolt shown clamps together the two flanges, and the nut is screwed down so tight that the bolt is stretched 1/1000 inch. We will assume that the bolt is of such a size that the stress produced in it by this elongation is 1,000 pounds. If so, the flanges are pressed together with a force of 1,000 pounds. Supposing now that we pull the flanges apart in the manner shown by the arrows, with a force of 500 pounds. We cannot produce a greater stress in the bolt than 1,000 pounds until we stretch it a little more than it is stretched already. We cannot do this unless we separate the flanges, and it will take a pull of over 1,000 pounds to do that. Although the pull of 500 pounds adds nothing to the stress in the bolt, it does diminish the pressure between the flanges, which will be now the pressure holding them together, less the force pulling them apart, or 500 pounds. Exactly the same effects would have been noted had we chosen any other force than 500 pounds, provided it was less than 1,000 pounds. The stress in the bolt would not have been increased, but the pressure between the flanges would have been diminished by exactly the amount of the force applied.

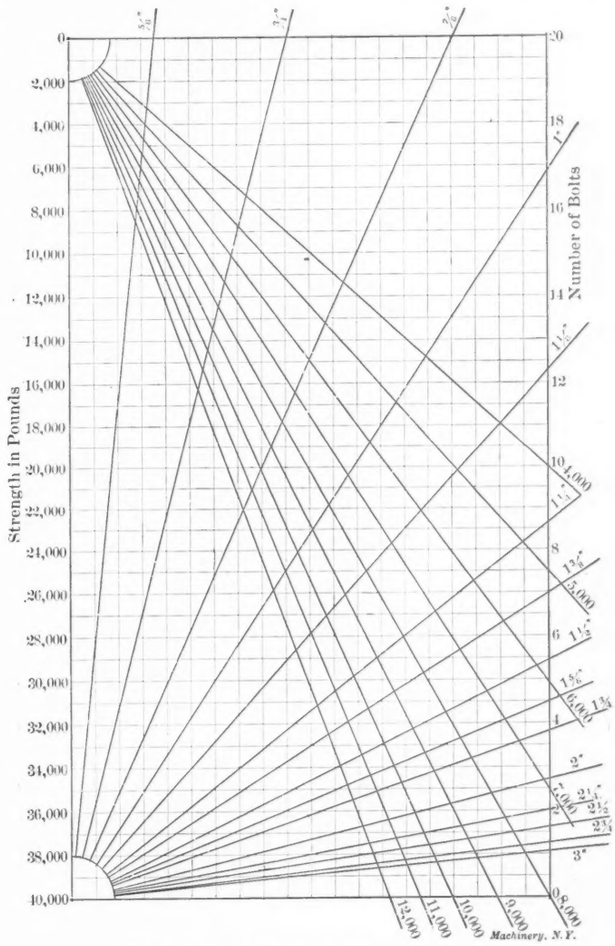

Fig. 5. Diagram of Working Strength of Bolts.

On the other hand, supposing that we apply a force of 2,000 pounds to separate the flanges, we will find that the bolt will stretch under this load 2/1000 inch, allowing the flanges to separate by only half that amount, and the pressure between them is nothing. It follows then that the stress in the bolt is now 2,000 pounds. If we had chosen any other force greater than 1,000 pounds, it would have been sufficient to separate the flanges, and the stress in the bolt would have been equal to the force applied. In other words, we find that

the stress in the bolt is always either the initial stress, or else the force tending to separate the flanges, and it is always the greater of the two.

If, however, we place a piece of packing between the faces of the flanges, we find it is the packing rather than the bolt that is elastic. On tightening up the nut the packing will be compressed say 1/100 inch. The stress in the bolt we will again assume to be 1,000 pounds. Applying a force of 500 pounds in the same manner as before, as shown in Fig. 2, we will not stretch the bolt very much in comparison to the amount by which we have already compressed the packing. Hence the packing will maintain its pressure against the flanges with almost undiminished force. We have simply added the 500 pounds to the 1,000 pounds stress already in the bolt. Exactly the same thing occurs when the force is increased to 2,000 pounds. The bolt will not give sufficiently to materially reduce the pressure due to the elasticity of the packing, and the stress in the bolt is the initial stress, plus the stress due to the force tending to separate the flanges.

The principles involved in the above discussion may be more easily understood by a reference to the illustrations, Figs. 3 and 4. The yielding members in Figs. 1 and 2 are represented in Figs. 3 and 4 as springs. A few moments consideration of the forces acting in each case will convince one of the truth of these two rules: 1. When the bolt is more elastic than the material it compresses, the stress in the bolt is either the initial stress or the force applied, whichever is greater; and 2. When the material compressed is more elastic than the bolt, the stress in the bolt is the sum of the initial stress, and the force applied.

Some experiments were made at the mechanical laboratories of Sibley College, Cornell University, some years ago to determine the initial stress due to screwing up the bolts in a packed joint in an effort to get it steam-tight. The tests were made with ½, ¾, 1, and 1¼-inch bolts. Twelve experienced mechanics were allowed to select their own wrenches, and tighten up three bolts of each size in the same way as they would in making a steam-tight joint. The bolts were so connected in a testing machine that the stress produced was accurately weighed. The wrenches chosen were from 10 to 12 inches long in the case of the ½-inch bolts, and ranged up to 18 to 22 inches long in the case of the 1¼-inch bolts. Thirty-six tests were made with each size of bolt, and while the results were not very close together in all cases, it was shown that the stress in the bolt due to screwing up varies about as its diameter, and that the stress produced in this way is often sufficient to break off a ½-inch bolt, but never anything larger.

Now since the stress varies as the diameter of the bolt, and the area varies about as the square of the diameter, it is evident that the larger the bolt is the greater the margin of safety it will have. If the stress in a ½-inch bolt is equal to its tensile strength, the stress in a 1-inch bolt will be about one-half its tensile strength, and in a 2-inch bolt, one-quarter of its tensile strength. These are very low factors of safety, especially in the case of the sizes commonly used. When we come to add the stress due to the force tending to separate the flanges, there is an exceedingly small margin left, which is in many cases absolutely wiped out by any sudden increase of pressure due to water hammer, or some similar cause. If, however, we are to use the same factors of safety in designing the bolting for packed joints as we do in designing the other parts of machinery, we would use nothing smaller than 1¼-inch bolts under any circumstances, and generally bolts ½ inch or so larger. Such a proposition as this seems ridiculous in the light of successful practice, and so the writer was moved some time since to investigate a great many flanged joints, some successful and some otherwise, with a view to obtain if possible some rule for proportioning the bolts so that they can always be relied upon.

From this investigation it was found that we may take for the "working section" of a bolt in a joint: *its area at the root of the thread, less the area of a ½-inch bolt at the root of the thread times twice the diameter of the given bolt, in inches.* This working section must be sufficient to sustain, with a lateral factor of safety, the stress due to the steam load, or other force tending to separate the flanges. The largest unit stress, found by dividing the stress due to the load on the bolt produced by the steam pressure, or other such cause, by the working section of the bolt, is about 10,000 pounds per square inch. Let us take as an example of the application of this rule the case of an inch bolt. Its area at the root of the thread is 0.550 square inches. Twice its diameter in inches is 2. The area of a ½-inch bolt at the root of the thread is 0.126 square inches. If from 0.550 square inches we subtract 2×0.126 square inches the result, 0.298 square inches, is the working section of the 1-inch bolt. At 10,000 pounds to the square inch this bolt will sustain a stress of not quite 3,000 pounds, in addition to the stress due to screwing up.

There is reason, although not very sound, for this allowance. It has already been noted that a ½-inch bolt will sometimes be twisted off in screwing it up to make a steam-tight joint. It has also been noted that an inch bolt will have twice the initial stress due to this cause that a ½-inch bolt will. Therefore if we could divide the area of the inch bolt into two parts, 0.252 square inches of it would be strained to the breaking limit, resisting the initial stress, and the rest of the area, 0.298 square inches, would be free to tend to the other stresses that might come upon it. As a matter of fact, we cannot so divide the area, so the reasoning is not very sound, but inasmuch as the rule corresponds to the best practice in this regard, while theoretically more perfect rules would give us excessive and undesirable diameters, it seems better to use it than to adopt the familiar method of using a high factor of safety, and paying no attention to the initial stress. The latter method invariably leads one to grief, unless one is familiar by long experience with the proper working stress to use with each size of bolt.

It will be found that for ordinary sizes of bolts the above rule works out in about the following form:

$$S = f\ (0.55\ D^2 - 0.25D).$$

Where S = the strength of the bolt when used in a packed joint,

D = the diameter of the bolt in inches.

f = the safe working stress in pounds per square inch.

This formula is simple to use, and not difficult to remember. It must be borne in mind that it is only approximate, and not exact. As an example of its use, we will take the case of the inch bolt again. Using a working strength of 10,000 pounds per square inch it will be found that

$$S = 10{,}000\ (0.55 - 0.25) = 3{,}000.$$

As the sizes of the bolts become greater, the formula gives results lower than they should be. It is very nearly correct for the common sizes of bolts, and on the safe side for the uncommon sizes.

The table and the diagrams (Fig. 5) have been prepared, giving the diameters, least areas, working sections, and strengths of different sizes of bolts with U. S. standard threads. Thus from the table we find that the area of a 1¼-inch bolt, at the root of the thread, is 0.893 square inch. Its working section is 0.578 square inch, and its strength at 8,000 pounds per square inch working stress is 4,624 pounds. As an example in the use of the table, let us design the bolting of a valve chest 8 inches wide and 12 inches long. Let us assume that the steam pressure is 100 pounds per square inch, and that ten bolts will be needed. The total load on the ten bolts will then be $8 \times 12 \times 100$, or 9,600 pounds. The load per bolt is 960 pounds. Assuming a working stress of 6,000 pounds, we find that a ⅞-inch bolt is necessary.

The diagram, Fig. 5, gives the strength of any number of bolts, of any given size, with any required working stress when used in a packed joint. Supposing that it is required to find the strength of 20 ¾-inch bolts when used with a working stress of 6,000 pounds to the square inch. Finding the figure "20" at the right-hand side of the chart, we follow horizontally to the left on the heavy line, until we reach the diagonal line marked ¾ inch. We then descend the vertical line which intersects the line ¾-inch at the same point as does line 20, until this vertical line intersects the diagonal line marked 6,000. We then follow the horizontal line which intersects line 6,000 at this point, to the left-hand edge of the chart, where the figures adjacent indicate that the answer is

13,500 pounds. If the reader wishes to check his answer from the table he will find that the strength of a ¾-inch bolt at 6,000 pounds working stress is 678 pounds, and therefore the strength of 20 of them is 13,560 pounds.

In designing flanged joints it must be remembered that an unlimited number of bolts cannot be crowded into a flange. The largest number of bolts that it is possible to use in a flanged joint and still have room to turn the nuts with an ordinary wrench is equal to the diameter of the bolt circle, divided by the diameter of the bolts, both in inches. A greater number of bolts than this can be used if necessary but a special form of wrench must be provided. The number of bolts generally used is about $D - 2\sqrt{D} + 8$, where D is the diameter of the interior of the pipe or cylinder in inches. For ordinary pressures this does not crowd the bolts too closely, although it puts them close enough together so that the flange will not leak under steam. The number of bolts actually taken for any flange is usually the nearest number divisible by four. For instance, for a water chamber 60 inches diameter, the number of bolts obtained from the formula is $60 - 2\sqrt{60} + 8$, or 52½. The number of bolts actually taken might be 52 or 56, probably 52.

For our last problem let us take a rather extreme case. We will suppose the case of the water chambers of a high-

WORKING STRENGTH OF BOLTS.

Diameter of Bolt, inches.	Area at Root of Thread, square inches.	Working Section, square inches.	Strength of Bolt, 5000 pounds Stress.	Strength of Bolt, 6,000 pounds Stress.	Strength of Bolt, 7,000 pounds Stress.	Strength of Bolt, 8,000 pounds Stress.	Strength of Bolt, 10,000 pounds Stress.	Strength of Bolt, 12,000 pounds Stress.
1/2	.126	0	0	0	0	0	0	0
5/8	.202	.044	220	264	308	352	440	528
3/4	.302	.113	565	678	791	904	1,130	1,356
7/8	.420	.200	1,000	1,200	1,400	1,600	2,000	2,400
1	.550	.298	1,490	1,788	2,086	2,384	2,980	3,476
1 1/8	.694	.411	2,055	2,466	2,877	3,288	4,110	4,932
1 1/4	.893	.578	2,890	3,468	4,046	4,624	5,780	6,936
1 3/8	1.057	.710	3,550	4,260	4,970	5,680	7,100	8,520
1 1/2	1.295	.917	4,585	5,502	6,419	7,336	9,170	10,504
1 5/8	1.515	1.105	5,525	6,630	7,735	8,840	11,050	13,260
1 3/4	1.746	1.305	6,525	7,830	9,135	10,440	13,050	15,660
1 7/8	2.051	1.578	7,890	9,468	11,046	12,624	15,780	18,936
2	2.302	1.798	8,990	10,788	12,586	14,384	17,980	21,576
2 1/4	3.023	2.456	12,280	14,736	17,192	19,648	24,560	29,472
2 1/2	3.719	3.089	15,445	18,534	21,623	24,712	30,890	37,068
2 3/4	4.620	3.927	19,635	23,562	27,489	31,416	39,270	47,124
3	5.428	4.672	23,360	28,032	32,704	37,376	46,720	56,064
3 1/4	6.510	5.690	28,450	34,140	39,830	45,520	56,900	68,280
3 1/2	7.548	6.666	33,330	39,996	46,664	53,328	66,660	79,992

pressure mining pump, 30 inches internal diameter, and subject to a pressure of 500 pounds per square inch. The number of bolts taken will be $30 - 2\sqrt{30} + 8$, or taking the nearest number exactly divisible by four, 28 bolts. The area of the 30 inch circle is 0.7854×30^2, or 706.86 square inches. The total load on all the bolts due to the water pressure is 706.86×500, or 353,430 pounds. It will be noted that the diagram which we have already used does not extend above 40,000 pounds strength, but by multiplying both the number of pounds strength and the number of bolts by 10 the effective range can be increased to 400,000 pounds strength and 200 bolts. Taking, then, 35,300 instead of 353,000 at the left-hand edge of the chart, we follow to the right to the intersection with the diagonal line marked 8,000, then ascend the vertical line passing through this intersection till it meets horizontal line 2.8, we find that this point falls between the radial lines marked 1¾-inch and 2 inches, thus indicating that 28 bolts 1¾-inch diameter are not strong enough, and 28 bolts 2 inches diameter are stronger than is necessary. In fact the vertical line we have been following intersects the line marked 2 inches at the horizontal line 2.4, indicating that 24 2-inch bolts would be required.

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There is at present about 225,000 miles of cable at the bottom of the sea, representing a cost of about $250,000,000. On an average 15,000 messages are conveyed by the world's cables a day, 90 per cent of which are sent in code or cipher.

A HUGE ROLLING MILL ENGINE.

By the majority of managers, a Corliss Engine would doubtless have been considered out of place in a rolling mill fifteen years ago. At that time only the simple types of steam engines were used for such service, so that in the intervening years and up to the present, there has been a greater improvement in the character of steam engines used for driving rolling mills than in all the years previous. The improvement that has taken place is not so much in the engines themselves, but in that those types have been introduced into rolling mills which formerly were considered poorly adapted to such use.

The illustrations shown herewith reproduce views of the first of six units built by the Allis-Chalmers Co. which represent the latest achievement in heavy rolling-mill engine design. Fig. 1 represents the latest view of a single slide and bed plate casting, 103 tons finished weight (see MACHINERY, August, 1906), which will be a portion of a 4,000-horsepower tandem rolling-mill engine, destined to be installed in the Edgar Thompson Works of the Carnegie Steel Company at Bessemer, Pa. The casting, which is shown ready for shipment, is the largest one ever poured by the company, and it stands on one of their special sixteen-wheel flat cars.

All through the progress of its manufacture this engine has been remarkable on account of the size of its parts and for the unusual features attendant upon its construction. For example, the pattern from which the molds were made for this heavy piece, possesses the following interesting features: It measures 32 feet in length, 11 feet in width and 10 feet in height, representing the work of ten expert patternmakers

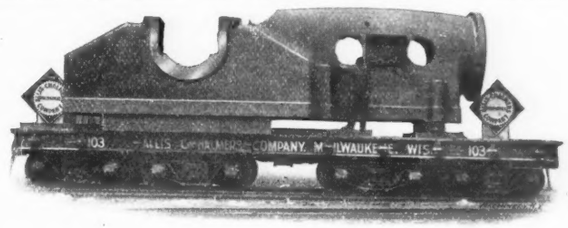

Fig. 1. 103-ton Finished Bedplate on Special Flat Car.

working steadily for a period of over four months. The amount of lumber used in its construction aggregated 22,000 feet. The pit, in which the casting was poured, measured 40 feet by 15 feet by 11 feet deep, in which 108 tons of metal were poured for the rough casting, which process consumed some eight to ten minutes' time. Nine ladles, four with a capacity of 25 tons each, one of 13 tons and four of 5 tons each, or 133 tons total capacity were used in the operation.

In a rolling mill engine with a capacity like the one mentioned, whose required horsepower will vary from the mere friction load of the empty rolls to a maximum of 4,000 horsepower in the severest kind of service, there is a marked advantage in designing the frame and other parts as heavy as possible so as to secure the greatest possible rigidity to withstand the racking strain of rolling mill service. An extra amount of ingenuity was required in the handling of a piece of this size, however, in the process of building. In the first place, a piece of this weight being very exceptional, especial precautions were taken against any mishaps in the process. Three cranes, with ample overload capacities and a rated aggregate of 145 tons, were used in conjunction to lift the casting from its pit. A special tackle was devised so that the lifts should be straight upward, applied at the ends of the heaviest of trussed steel lifting bars.

The casting, after being deposited beside its pit, was allowed to cool for fifteen days before the operation of cleaning it was begun. The heat still given off, after approximately twenty days' cooling, could be felt several feet away from the huge mass. During the cleaning process, three men were able to work abreast inside the slide aperture, while standing upright, and without perceptible crowding.

Fig. 2 shows the engine as it stood on the floor of the West Allis shops, partly erected. It is one of two similar units ordered for the Edgar Thompson Works and has 50 and 78

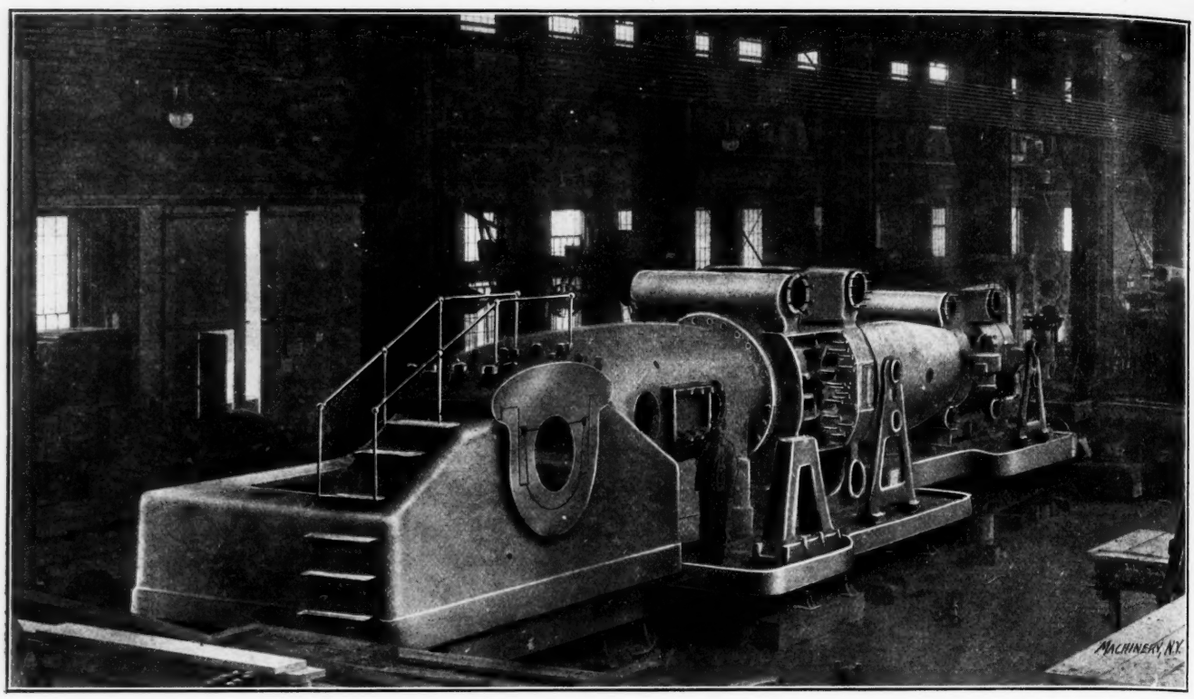

Fig. 2. Tandem Compound Rolling Mill Engine of Extremely Heavy Design, in the Erecting Shop of the Allis-Chalmers Co.

inches cylinder diameter by 60 inches stroke. One engine is a right-hand and the other a left-hand. The frame portion has broad bearing surfaces to rest on the foundation, and plates cast in the bottoms to form receptacles for oil thrown off by

¾-stroke valve gear, of exceptionally heavy design and with valves double-ported. The governor will be of special weighted pattern for operating the high- and low-pressure cut-off. In addition, there will be provided a hand adjustment for the

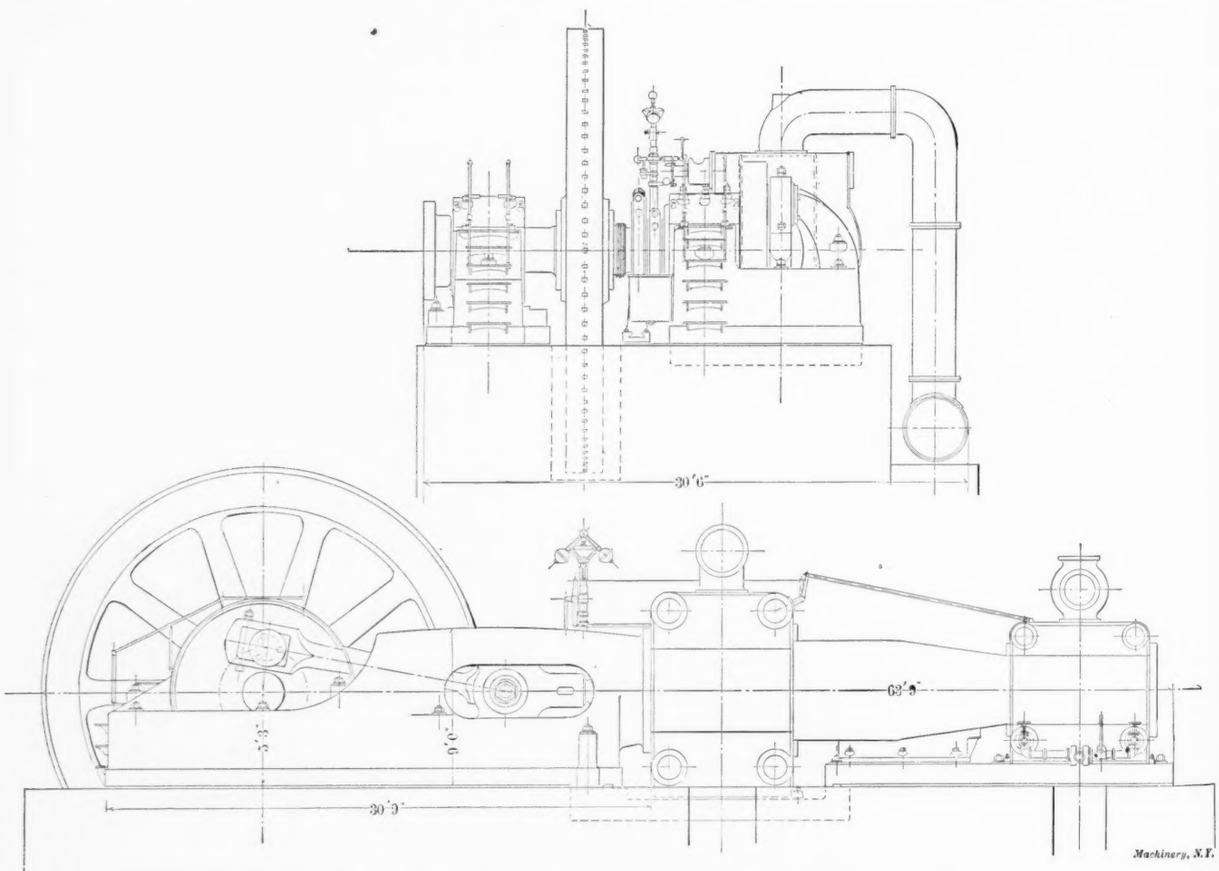

Fig. 3. Side and End Elevations of Large Rolling Mill Engine. Cast Steel Flywheel, Weight, 224,000 Pounds.

crankpins, journals, etc. The frame is reinforced by a heavy pad cast directly beneath the main bearing and below the general level of the foundation.

The cylinders are fitted with Reynolds-Corliss automatic low-pressure cylinder which can be connected or disconnected so that both valve gears will be under the control of the governor, or the low-pressure adjustable by hand. The governor will be provided with an automatic belt rider safety stop.

The general dimensions of the engine are indicated in Figs. 3 and 4, which show side and end elevations and plan. The flywheel has a diameter of 25 feet and a face of 25 inches. It is made of cast steel and weighs 224,000 pounds. A further idea of the immensity and weight of this engine can be gained from the facts that the crankpin is 20 x 18 inches; crosshead pin, 18 x 18 inches; journals, 30 x 78 inches, and total weight 980,000 pounds. The steam pressure is 150 pounds per square inch and the speed is 100 revolutions per minute.

Anticipating considerable difficulty in handling the heavy parts for this great engine and those which are to follow, special flat cars, two in number, were ordered months ago, to be built at the West Milwaukee works of the C. M. & St. P. Ry. Co. These cars, one of which is shown in Fig. 1, are unique in design and apparatus. The cars utilized up to the present time have had maximum capacities of from 60 to 70 tons. The needs in the present case, requiring over 100 tons capacity, however, had to be met by an entirely different construction. These cars have a rated capacity of 100 tons and are said to be the first of their kind in existence. In length, 40 feet 2 inches, they have several feet advantage over the ordinary car. They have four trucks of four wheels each, or sixteen wheels in all, or twice the usual number. This car has a wheel base of 36 feet 2 inches; journals 5½ inches by 10 inches; wheels, diameter, 33 inches standard.

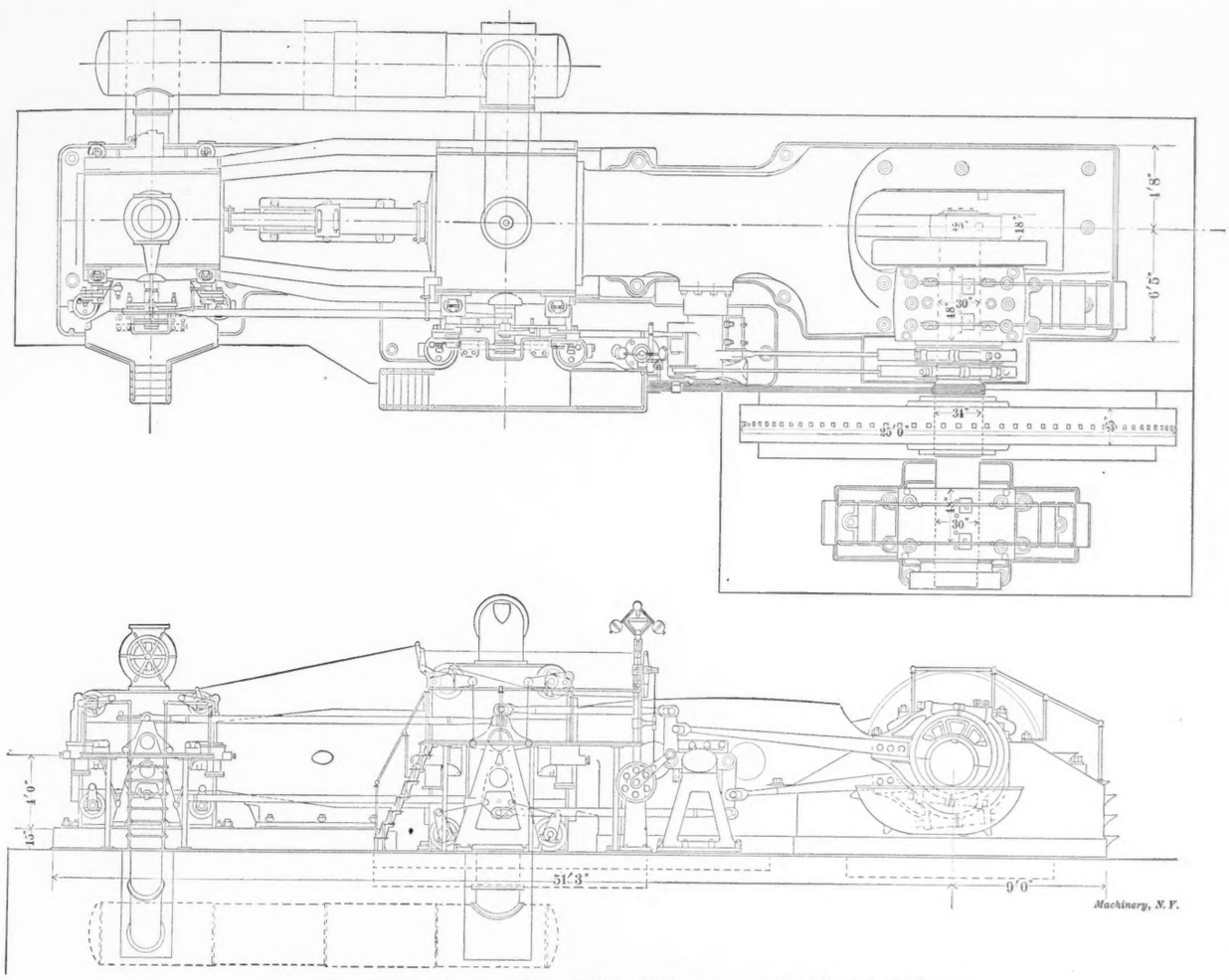

Fig. 4. Side Elevation and Plan of Heavy Rolling Mill Engine. Total Weight, 980,000 Pounds.

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In many of our English contemporaries we find complaints about the destructive influence of the automobile on the roads of the country, and a new problem has arisen in the form of producing comparatively dustless country roads. The automobile which so far, with few exceptions, has been little but a toy proves to be a very expensive one, not only to individual owners, but to the countries at large where it is much used.

BRAKES.—4.

COIL BRAKES.

C. F. BLAKE.

The coil brake, a sectional view of which is seen in Fig. 11, is much used as an automatic brake in place of the washer disk type. This brake is in effect an internal band brake. The ratio between the tensions at the ends of the strap equals k; the value of k is obtained by the formula:

$$\text{Log}_e\ k = f \times \frac{l}{r},$$

where f is the coefficient of friction, l the length of the circular arc in contact with the strap, and r the radius of the drum. The following table gives the value of k figured for a coefficient of friction equal to 1-3 for various arcs of contact.

Arc of Contact.		k
360 degrees	1 rev.	8.121
720 degrees	2 rev.	65.950
1,440 degrees	4 rev.	4349.00
2,880 degrees	8 rev.	18914800.00
3,600 degrees	10 rev.	1247380000.00

In Fig. 11 the drum E is mounted upon the ends of the motor shaft F and the pinion shaft G, the former being loose, and the latter keyed in the drum. This type is known as a double shaft brake, but may also be made as a single shaft brake by mounting the pinion on a sleeve of the drum similar to the single shaft disk brake in Fig. 8. (See MACHINERY, October, 1906.) The single shaft brake is preferred by many designers, including the writer.

The coil A is made of a flat rod wound into a helix and ground to gage as to external and internal diameters, the former being made slightly greater than the internal diameter of the casing B, so that the coil must be slightly com-

pressed upon assembling the brake, thus insuring contact between the coil and the casing at all times. One end of the coil is fastened to the flange *D*, which is keyed to the shaft *F*, and the other end is fastened to the drum *E*. The fastenings of the coil ends must each be made in a manner to resist the thrust of the coil, and the fastening to flange *D* must be such as to resist a certain amount of tension also as the load is lowered.

The coils have been made of various materials and in various ways. A very successful coil has been made of steel by turning it out of a hollow forging previously finished to the proper inside and outside diameters. Another successful coil is made of tobin bronze bars, coiled, and afterwards ground to the proper diameters.

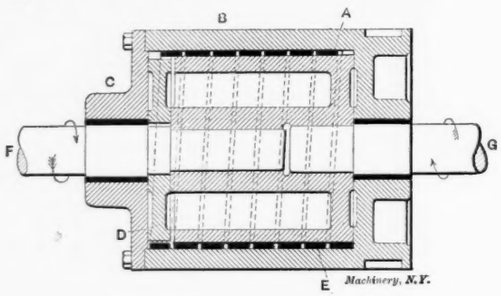


Fig. 11. Coil Brake.

Like the band brake, the wear upon the coil is greater at the load end than at the power end, a point that has brought this brake some disfavor. If properly designed, however, with ample friction surface and many coils of the helix *A*, together with proper lubrication and sufficient heat radiating surface, it has proven one of the best and most satisfactory types of brake, and seems especially adaptable to the electric crane.

In hoisting the load the shaft *F* turns in the direction of the arrow at the left, thereby expanding the coil against the casing, and causing the drum *E* and shaft *G* to revolve as one with the casing.

When holding a suspended load the shaft *G* and drum *E* tend to turn in the direction of the arrow at the left, under the action of the load, thus expanding the coil against the

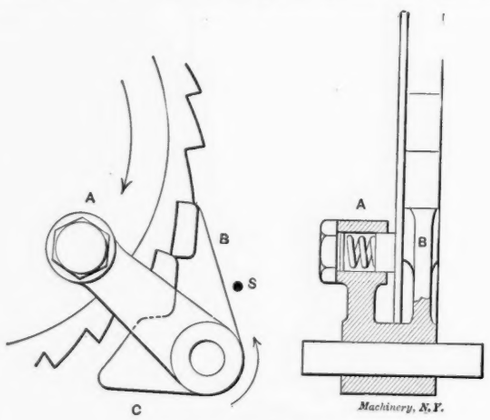


Fig. 12. Brake Pawl.

casing which is prevented from turning by pawls engaging the ratchet teeth on the end of the casing.

To lower the load the motor turns in a direction opposite to the arrow at the left, thus releasing coil after coil from contact with the casing, and winding them on the drum *E*. When sufficient coils have been thus released so that the friction of those remaining in contact with the casing is insufficient to balance the load, the shaft *G* will turn under the influence of the load in the direction of the right hand arrow, thus again expanding the coil sufficiently to hold the load.

In exactly the same manner as with the disk brake, this cycle of events is repeated an infinite number of times in a unit of time, thus causing a uniform descent of the load.

A positive jaw drive should be arranged for between the flange *D* and the drum *E* to come into engagement before the coil is worn beyond the point of properly engaging the casing when expanded.

Ratchet Pawls.

Figs. 12, 13, and 14 show the brake pawls or silent ratchets in common use with automatic brakes. These consist of a

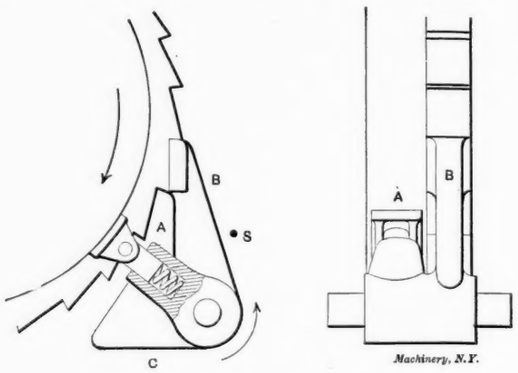


Fig. 13. Brake Pawl.

pawl, usually counterweighted to throw itself into engagement with the ratchet, and a friction arm bearing upon some portion of the revolving ratchet in such a manner as to throw the pawl into engagement when the ratchet rotates in one direction, and out of engagement upon the opposite rotation.

In these figures *A* is the arm radial to the ratchet, *B* the pawl, *C* the counterweight, and *S* a stop to prevent the pawl being thrown too far out of engagement. The arrows show the relative movements of the ratchet and pawl to throw the latter into engagement.

In Fig. 12, the arm *A* carries a friction block, either brass or wood, which is pressed by the spring into contact with a finished ring upon the ratchet wheel, the friction surface being normal to the ratchet shaft. This style of pawl would be used with the brake shown in Fig. 8.

In Fig. 13, the arm *A* carries a small piston and shoe which is pressed radially against the periphery of a finished ring on the ratchet, the friction surface being parallel to the ratchet shaft. This style would be used with the brake shown in Fig. 11.

Fig. 14 shows a common arrangement of two pawls so placed that when one is in engagement the other is half a tooth out of engagement, thus obtaining the strength of a

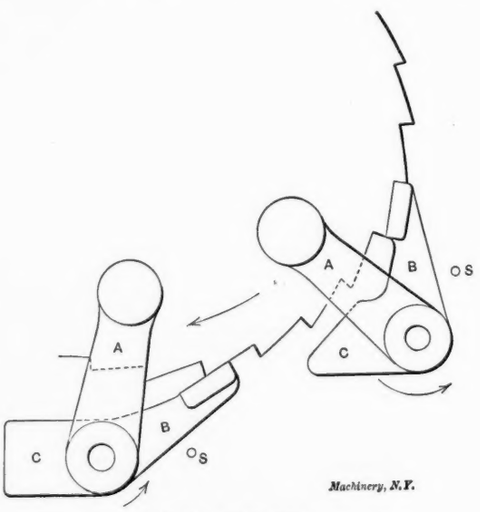


Fig. 14. Brake Pawl.

coarse pitch ratchet, with the promptness of action of a fine pitch. The arrows on the ratchets show the direction of rotation when lowering the load. In hoisting, the friction surface on the ratchet slips under the shoe of the arm *A*, thus keeping the pawl *B* pressed against the stop *S*, and free from the ratchet, *A*.

THE STRENGTH OF A MOUTHPIECE RING AND COVER.

There are thousands of digesters, vulcanizers and other similar vessels in use working under considerable pressure. Accidents to these, particularly the bursting of the head or of the ring to which it is clamped, are almost as common as boiler explosions, and oftentimes do considerable damage and sometimes result in the loss of life. There are one or two points relating to the problem of designing vessels of this kind which do not always receive proper attention from the men responsible for the calculations involved, and it is with the object of calling attention to some of these points that we give herewith the calculations made for figuring the strength of a cover and mouthpiece ring, concerning whose safety a subscriber has asked our opinion.

Fig. 1 shows the essential features of the design. The body of the cylinder itself was a welded steel tube 4 feet in diameter ½ inch thick and about 7 feet long. To this was riveted a mouthpiece ring, presumably of cast iron, having slots for 24 one-inch steel bolts by which the cover was made fast. The important dimensions are shown. No other infor-

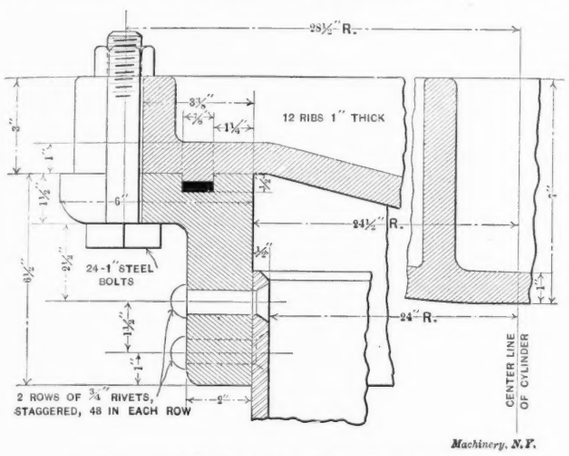


Fig. 1. Original Design of Mouthpiece Ring and Cover.

mation being at hand, the material of the cover is taken as cast iron, while the shell is supposed to be made of steel having a tensile strength about equal to that of boiler plate. The following data as to the strength of the materials is assumed:

Factor of safety	5
Cast iron, ultimate tensile strength	20,000 pounds
Steel shell, ultimate tensile strength	55,000 pounds
Rivets, ultimate shearing strength	40,000 pounds
Rivets, ultimate bearing strength	90,000 pounds
Steel bolt, working tensile stress	4,000 pounds
Working pressure to which vessel is subjected,	60 pounds per square inch.

The blueprint from which these details were taken calls for a testing pressure of 125 pounds per square inch. On this question something will be said later.

The ways in which it is possible for this structure to fail are almost too numerous to catalogue. A rapid inspection, however, shows the following as being the only ones which we need to consider:

First, bursting of the cylinder head.

Second, rupture of cover bolts.

Third, failure of rivets from shearing.

Fourth, failure of mouthpiece ring from tensile stresses in lower edge of the hub.

In considering failure from the first cause, the cover may be treated the same as the cylinder head of an engine would be. The formulas given in Kent's Handbook for determining the thickness of cylinder heads may be used; a number of different ones will be found there. Taking, for instance, Thurston's rule, the first one given:

$$t = \frac{Dp}{3{,}000} + \tfrac{1}{4}$$

in which D is the diameter of the circle in which the thickness is taken, p is the maximum working pressure per square inch, and t is the thickness of the head. Substituting the known values in this equation we have

$$t = \frac{52 \times 60}{3{,}000} + \tfrac{1}{4} \text{ inch} = 1.040 + 0.250 = 1.290 \text{ inch.}$$

The diameter taken is, roughly, the diameter of the gasket. The result, 1.290 inch, is found to be somewhat greater than the figure given on the sketch, but to the cover there shown is added the strengthening effect of the heavy ribs provided; the cover with these should be entirely satisfactory for a working pressure of 60 pounds. The crowning shape of this part also adds to its strength.

The strength of the bolts to resist rupture will next be considered. The inside diameter of the gasket is 4 feet 3½ inches, or 51½ inches, and the area of a 51½-inch circle is about 2,100 square inches. With a pressure of 60 pounds per square inch this gives a total load on the head equal to 2,100 × 60 = 126,000 pounds. Since there are 24 cover bolts the pressure sustained by each cover bolt will be 126,000 pounds divided by 24, or 5,250 pounds, the amount due to the steam pressure. The area of a 1-inch United States standard bolt at the bottom of the thread is about 0.55 square inch. The fiber stress in the bolt due to the steam pressure will then be 5,250 ÷ 0.55 = 9,550 pounds, about. This figure in itself is well within the safe limit for steel of the quality from which such bolts are usually made. We have, however, to reckon with a number of other factors. We have, for instance, to consider the old question as to whether there is any greater tension on the cover bolts after the steam has been turned on above the initial tension due to the tightening of the cover. With the elastic gasket used it can be shown that the steam pressure will be added to the tension produced by setting up the bolts, which will thus have to be stronger than they would if a metal to metal joint were provided. For a full discussion of the question of the stresses in cover bolts the reader is referred to a paper read by Carl Hering before the Engineers' Club of Philadelphia, January, 1906, and the leading article in this issue. Considering that these bolts will be tightened by comparatively ignorant men, opened and closed a number of times a day, and are certain at some time to be overstrained and that the constant use to which they are subjected will tend in time to weaken the material through fatigue, it is not at all advisable to put a stress of more than 4,000 pounds per square inch on these bolts. It is suggested that the diameter of these bolts be increased to 1¼ inch and that their number be increased to 36. We would then have for the tension of each bolt 126,000 ÷ 36 = 3,500 pounds, and since the area of a 1¼-inch bolt at the root of the thread is about 0.89 square inch, the stress on the bolt will be 3,500 ÷ 0.89 = 3,930 pounds per square inch. This is none too low, taking into account the elastic gasket and the possibility of abnormal tightening through the occasional use of a pipe extension to the wrench.

Calculation for the strength of the rivets in shear is very simple. There are 96 of these rivets so that each of them bears as its part of the load on the cover an amount equal to

$$\frac{24.5^2 \times \pi \times 60}{96} = 1{,}180 \text{ pounds, about.}$$

This amount divided by 0.44, the area of a ¾-inch ring, gives a shearing stress of 2,680 pounds, a figure which need never cause the slightest anxiety. The bearing value of the rivet will be proportionately low.

The last question to be considered, that of the tensile stress in the lower edge of the hub of the ring, is discussed at length in *The Locomotive*, issue of July, 1905, published by the Hartford Steam Boiler Inspection and Insurance Co. This cause of failure was, until recently, a rather obscure one. The cut, Fig. 2, shows the action which causes the deformation. There is an upward pull of the cover bolts at P with a downward pressure of the gasket at Q and a further downward pull at S due to the pressure of the steam on the bottom of the vessel. These three forces, working together, tend to turn the ring inside out, as we might say, elevating the outer edge and depressing the inner edge, and thus expanding the lower portion of the hub. From this distortion the principal

stress is that of tension in the hub. The way in which the part fails under these circumstances is shown in Fig. 3. "Hub cracks" are introduced running from the lower edge up into the body of the ring, sometimes passing through the rivet holes and sometimes avoiding them. The formula given in *The Locomotive* for determining the maximum tensile stress at this point is as follows:

$$F = \frac{(m\,N\,E + L\,D)\ (h - a)}{6.2832\ (I - a^2\,A)}$$

in which F = the tensile stress per square inch,

m = the distance from the gasket to the bolt circle,

N = the total number of the cover bolts,

E = the excess of the actual tension on each cover bolt above that due to the steam load (1,200 pounds is suggested in the article referred to),

L = total steam load,

D = the distance from the inner edge of the ring to the bolt circle.

h = height of the ring,

a = the distance from the center of gravity of the ring section to the face of the ring,

I = the moment of inertia of the ring section about axis $O\ X$ (see Figs. 4 and 5),

A = area of the ring section.

Those letters which refer to dimensions will be found in Fig. 4, where a diagrammatical sketch of the ring section is given. The quantity in the denominator $(I - a^2\,A)$ amounts to the same in the moment of inertia of the section about the neutral axis. It is put in the form given for convenience in calculating, the issue of *The Locomotive* referred to having a table of moments of inertia of rectangles provided for the purpose. No explanation need be given here of the methods of finding the center of gravity and moment of inertia of a section. This will be found discussed in the above mentioned article, or in any text book dealing with the strength of materials.

Drawing the diagram shown in Fig. 4 and for the sake of simplicity risking the leaving out of the gasket groove, we find the following values:

$A = 15\ 1/16$ square inches,

$a = 2.91$ inches,

I (about axis OX) $= 184.6$.

Substituting the known values in the equation above we have

$$F = \frac{(2\tfrac{5}{16} \times 24 \times 1200 + 126{,}000 \times 4)\ (6.5 - 2.91)}{6.2832\ (184.6 - 2.91^2 \times 15\tfrac{1}{16})} = 5.600 \text{ pounds}$$

20,000 pounds was taken as a safe figure for the tensile strength of cast iron. This is none too high, especially if great care is not taken in the selection of the iron and the

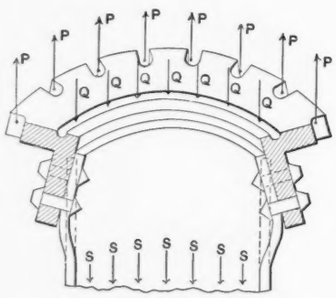


Fig. 2. Stresses on the Ring.

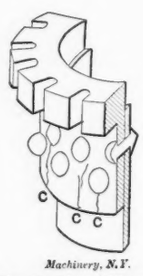


Fig. 3. Usual Manner of Failure.

inspection of the casting after it is completed. With a factor of safety of 5 we have 4,000 pounds as the safe figure for a working tensile strength. The results of our calculation would thus show that the stresses in the ring are high enough to be dangerous. To give the additional strength necessary the section shown in Fig. 5 is suggested. The hub has been made 1½ inch longer and the thickness of the flange has been increased about ½ inch. This latter change was made both to keep the parts in good proportion so far as looks are concerned, and from the fear, as well, that the ring might fail by breaking at the corner of the gasket groove. The possibility of this would be a rather difficult thing to calculate with assurance, but good judgment would seem to indicate that the casting is none too strong at this point. Repeating the same operation on this enlarged section that we went through in calculating the strength of the smaller section we have

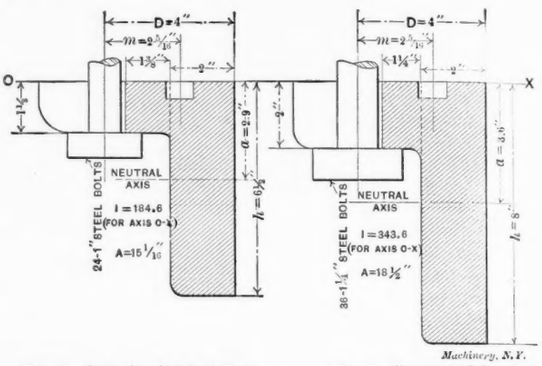


Fig. 4. Data for Original Ring.

Fig. 5. Suggested Section.

$A = 18\frac{1}{2}$ square inches,

$a = 3.6$ inches,

I (about axis $O\ X$) $= 343.6$.

Substituting the known values in the equation as before, we have

$$F = \frac{(2\tfrac{5}{16} \times 36 \times 1200 + 126{,}000 \times 4)\ (8 - 3.6)}{6.2832 \times (343.6 - 3.6^2 \times 18.5)} = 4{,}070 \text{ pounds.}$$

This figure, while a little large, may be considered safe perhaps if a good casting from a good quality of iron is used.

The value of E used above is that recommended in the discussion from which the formula was taken, namely 1,200 pounds. This is arbitrarily selected, and although it would seem somewhat low in view of the possibilities for excessive strain afforded by the wrench and pipe combination, the boiler insurance company referred to have found that the formula, as given, is rather on the side of safety. The large bolts suggested for the improved section are favorable for reducing the excess pressure, since the workman is not liable to overstrain a large bolt in the same proportion that he would a smaller one.

It would be unwise to conclude this article without some reference to the testing pressure called for on the blueprint. All the parts have thus far been figured out for a working pressure of 60 pounds. If this really is to be the *maximum* working pressure, and the parts have been proportioned with this figure in view, it is an exceedingly unwise thing to do to test the vessel at a pressure greatly in excess of this; 75 or 80 pounds at least should never be exceeded in testing the structure. Damage is often done by careless use of excessive pressures in testing, these injuries sometimes not showing at the time but working havoc later on. If the pressure in use will occasionally run up to a figure approaching 125 pounds per square inch that is another matter, and the whole design should be altered to make this possible without straining the parts beyond what they are able to bear.

* * *

What a fetish is the modern mover of things—electric power! "Lawn mowers ground by electricity; cutlery too," reads a sign in an East Orange, N. J., repair shop. What if the power were a gas engine? Would the owner then say the grinding was done by gas? Not likely, but why not? Is it not quite as true of one as the other?

* * *

The prosperity of the country seems to be indicated by the recent report of the Department of Agriculture, which states that farm values have increased about 37 per cent from 1900 until 1905. This statement, however, should be accepted conservatively, as there may, indeed, have been no increase whatever actually, the figures simply being indicative of the general rise in prices all along the line. While it is well to look cheerfully for the progress and well-being of the country, it is advisable not to overestimate our state of prosperity.

SPECIAL TOOLS FOR DRILLING HOLES IN TIME AND PERCUSSION FUSES AND FIRING RINGS.

W R. BOWERS.

The accompanying cuts show some special jigs for drilling holes in fuse components. In this class of work there are two important features, firstly, the holes have to be very accurate both as to size and position and, secondly, interchangeable work has to be turned out at the lowest possible cost. It is essential that the degree of accuracy should be very high, as the whole result of the firing of both large and small guns depends upon the correct working of the fuse attached to the projectile. A defective fuse would probably not only fail to act at its destination, but would be liable to explode the shell either before it left the gun, or at so short a distance away from it that the operators themselves would be in danger of annihilation or the gun itself damaged to such an extent as to be of no further use. There is, therefore, a grave responsibility resting upon those engaged in the manufacture of this class of work. Fig. 1 is a plan, elevation and sectional view of a jig for drilling three holes in a percussion fuse, and as will be seen in the section showing the depth gage in position, one hole passes right through the wall and for a short distance into the other side of the fuse, forming a flat bottomed recess which acts as a locking chamber for a centrifugal bolt which renders it entirely safe from premature explosion until the gun is fired. It is, of course, necessary that the hole is of proper diameter and depth. The fuse body is dropped into the jig as shown in the sectional view, and located on the center bolt as shown. The center bolt is drilled, hardened and lapped, and acts as a position stop, and as a guide for the drill when drilling the flat bottomed hole. The jig is provided with a movable plate and a screw plunger, which are removed from the jig to allow the fuse to be put in and taken out. The screw only requires about one turn to fasten the fuse in position. The jig is also provided with two extracting levers which are necessary to extract the fuse after drilling, owing to the close fit of the fuse in the jig. The three holes are all of different dimensions, and as two drills are used for the flat-bottomed hole, the work is done on a four-spindle drill press and all holes drilled at one setting, which ensures accuracy and speed. When the first hole is drilled a safety peg is pushed in to guard against any chance of the work moving during the drilling of the other holes. The method of gaging the flat-bottomed and most important hole will be readily understood from the cut. The plunger *a* is pressed down, pushing the plunger *b* forward, and if the hole is not of correct depth, it is immediately detected by the limit step on the body of the gage. If the hole is not at its correct distance from the bottom of the bore, which is very important, it is impossible for the plunger *b* to enter.

Fig. 2 shows a jig for drilling five holes in the stem of a time and percussion fuse at an angle of 75 degrees to the cen-

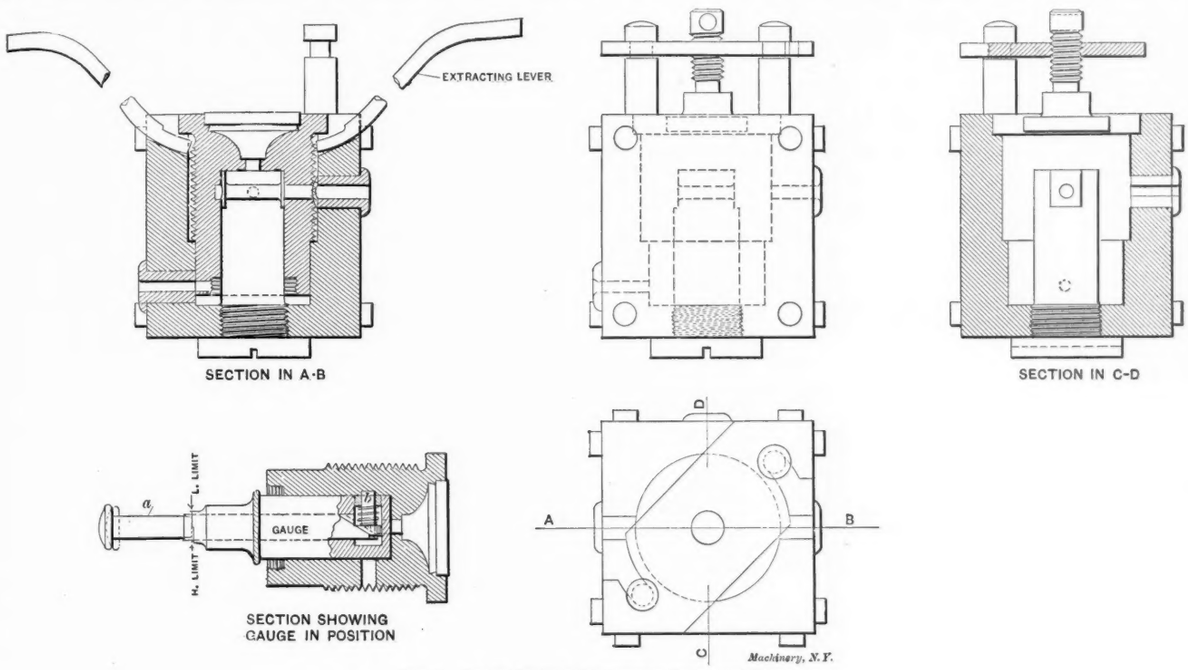


Fig. 1. Jig for Drilling Percussion Fuse, and Gage.

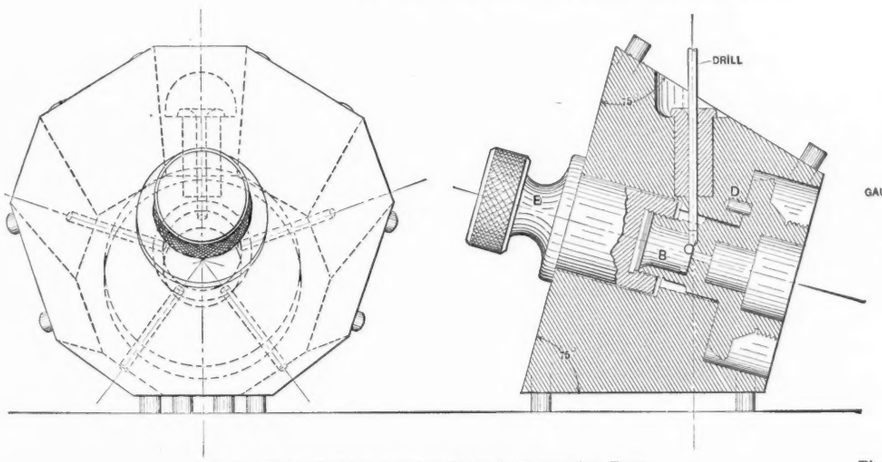


Fig. 2. Jig for Drilling Angular Holes in Percussion Fuse.

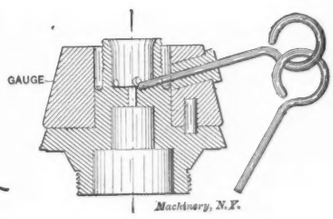


Fig. 3. Gage for Testing Angular Holes.

terline. The fuse body *B* is pushed into the jig from the front end and located by the position peg *D*, which serves the double purpose of locating the five holes in their proper position, and of preventing the fuse from turning during the drilling operation. The tightening bolt *E* is then screwed on the stem of the fuse and in conjunction with the position peg *D* holds the work perfectly secure. One of the five bushings in the jig is shown in section. The bushings are hardened and lapped, and are purposely made long, because when the drill breaks through the walls of the fuse body, it has to travel on a considerable distance to drill a half-round groove along the flat-bottomed cavity of the fuse stem. It is therefore desirable to have a good bearing to keep the drill up to the work. The method of gaging this operation is shown in Fig. 3. The gage is pushed on the fuse stem and has a position peg which fits a hole in the fuse; by the aid of two wire gages, the angle as well as the diameter of the holes are gaged.

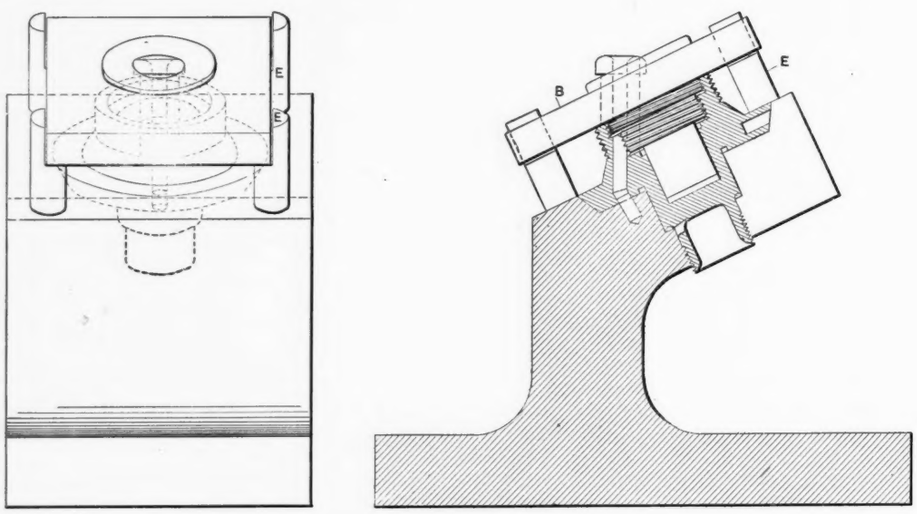


Fig. 4. Jig for Drilling Angular Hole in Percussion Fuse.

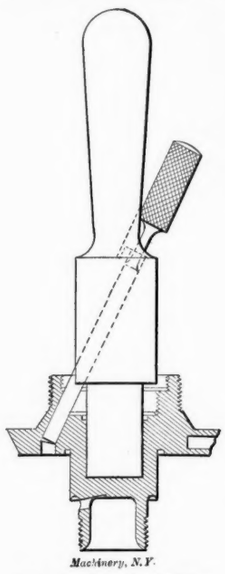


Fig. 5. Gage for Testing Angular Hole.

Fig. 4 shows another jig for drilling a hole in a time and percussion fuse at 25 degrees angle, and of a given depth to meet another hole running parallel to the axis of the fuse.

The fuse body is dropped into the jig and on to a position peg as shown, this being all that is required to keep the work in position. The drill bushing is mounted in a square plate *B*, which is held in position by the four upright standards *E* and provided with a stud entering the inside of the fuse body. The method of gaging the angle is shown in Fig. 5 and is a very severe test. In my experience (and I have been engaged in this class of work for years), I have never seen a jig which did better or quicker work than this one, and to those not engaged in this class of work, these special operations may be very interesting.

Fig. 6 shows a way of getting over what looks at first as a rather difficult job which had to be done in the shortest possible time, and without the aid of any expensive special machinery. The cut shows a firing ring for a time and percussion fuse fixed in position to have a hole drilled from its bore outwards at an angle of 81 degrees into the firing channel on the face of the ring. As the ring could not be drilled from the outside, I discarded any idea of using a drilling machine and jig for the purpose. I decided to use a screw machine with cross slide, and had a small fixture made to carry a train of gears to be driven from the countershaft above. I made the drill the axle for the smallest of the gears in the train, and by fixing a drum on the countershaft the belt was enabled to travel backward and forward and to follow the movement of the cross slide. The hole to be drilled was 0.157 inch diameter ± 0.002 inch. The drilling fixture had to be nicely fitted up and wearing parts hardened and ground to prevent backlash or poorly fitting surfaces. The fixture was mounted in one of the holes in the turret as shown in the cut. The holder for the firing ring was an angle plate bolted to the cross slide at the angle required, viz., 81 degrees. The firing ring being

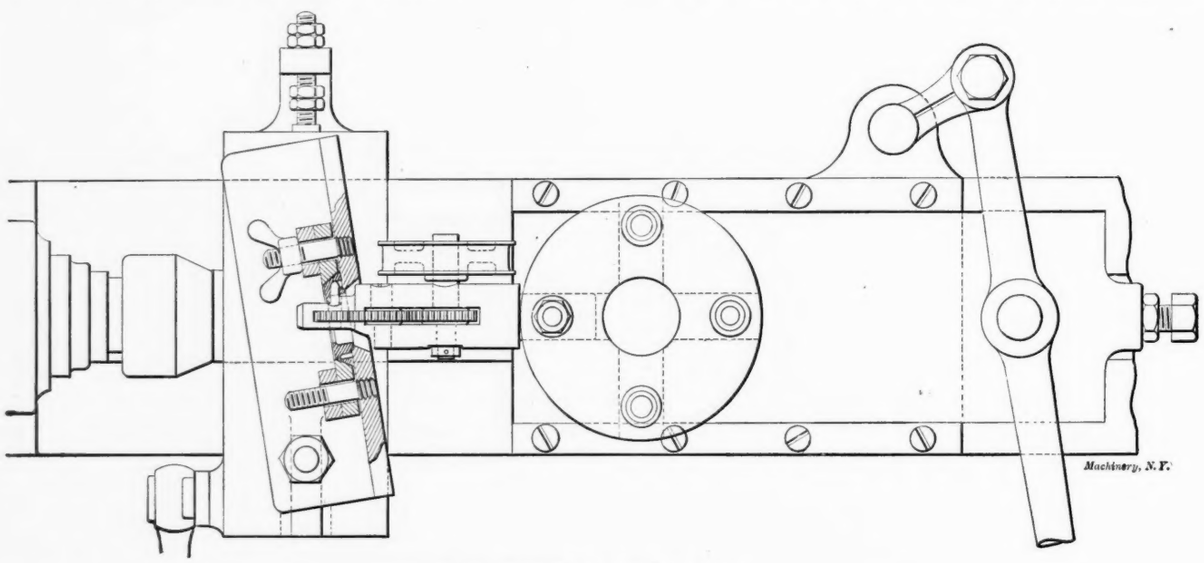


Fig. 6. Method of Drilling Firing Rings.

cone shaped on the outside, I had the plate *A*, Fig. 7, made with a hole bored out to drop over and slide on to the ring, and a packing piece *B*, Fig. 7, to drop on and take up the space that the plate *A* required to slide back to clear the ring. This saved a lot of time inasmuch as it obviated the necessity of a lot of screwing up and unscrewing every time a ring was drilled. With these plates one half turn of the wing nuts was sufficient to loosen the plates so that the finished firing ring could be removed. When the firing ring was

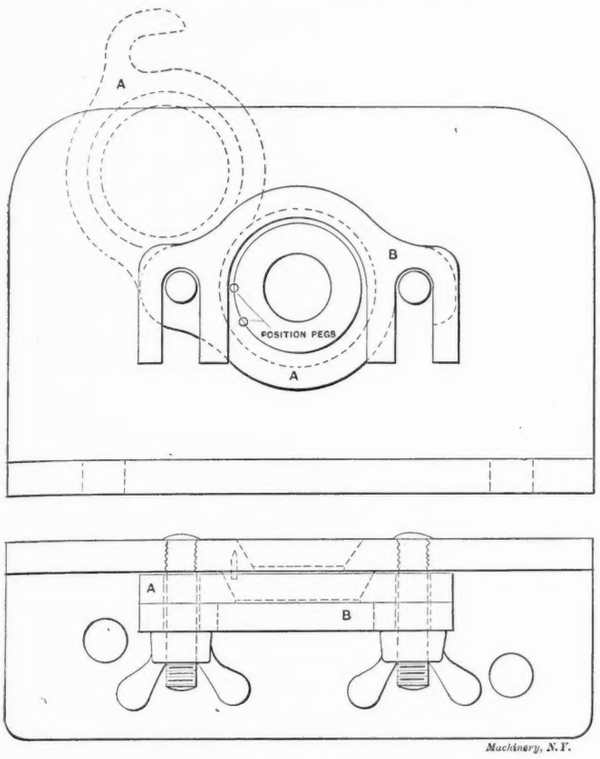


Fig. 7. Detail of Holding Device for Drilling Firing Rings.

fixed into position the operator had simply to move the cross slide back to its stop with his left hand, and, holding it there while he moved the turret slide forward to its stop with his right hand, he again moved the cross slide forward, bringing the work toward the drill until it reached its forward stop. He then simply reversed the movements and the job was done.

The countershaft was operated with the foot so that the drill was not running while change of work was going on, which

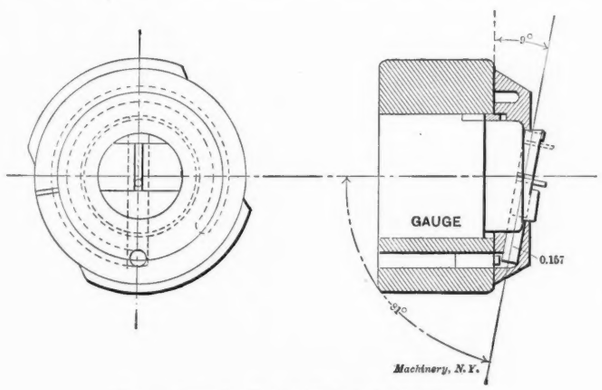


Fig. 8. Gage for Testing Hole in Firing Ring.

obviated a lot of unnecessary wear. The work came out with the greatest accuracy, the fixture gave no trouble, and one operator was able to drill 3,000 of these firing rings per day with comfort. Fig. 8 shows the method of gaging the angle of the hole, and it will be seen that if the work was not correct, the gage would very soon find it out. The diameter of the hole was gaged with a hook gage with maximum and minimum diameters on respective ends.

TRACING, LETTERING AND MOUNTING.—3.

I. G. BAYLEY.

Mounting.

Mounting Tracing Paper.—Tracings likely to be in hand a long time should be mounted to the drawing board, for several reasons. They will be protected from getting torn and will not shift on account of the sudden change of temperature of the room which may take place; they can also be cleaned more safely than if held by a few tacks.

The paper should be cut large enough to allow for sticking the edges to the board and should it be intended to color the tracing with liquid colors, twice the allowance should be made as the paper will be cut after the tracing is made, and mounted the second time.

The drawing to be traced should be laid down square with the board, perfectly flat and level, then thoroughly dusted down to remove all obstructions, as these cannot be removed after the tracing paper is mounted.

A long, flat straightedge with a couple of weights for each end is needed. Having cut the paper, dampen it slightly with a wet sponge, going over it very evenly and working quickly, so that it may be attached to the board before quite dry. The damp side must be up. The straightedge is placed an inch outside of the cutting-off line and the weights put on, one at each end. Turn up the edge of the tracing paper as shown in Fig. 22 and apply the mucilage or paste brush, pressing the edge down firmly with a straight-edged ruler or paper knife. The opposite side of the tracing paper is treated in the same way, and then the two remaining sides, care being taken to stretch the paper carefully by pulling the edge of the paper gently with the tips of the fingers, before the weights are put on the straightedge.

Any superfluous water may be removed with a blotter. The whole operation, as before stated, should be done very quickly, as in a warm room the paper soon dries.

Mounting Paper for Coloring.—Should there be any wash coloring to be done after the tracing is made, it is usually done on the back. The tracing is therefore taken up, cutting close to the pasted edge, so as to leave as much margin as possible for the second mounting. The drawing paper is also

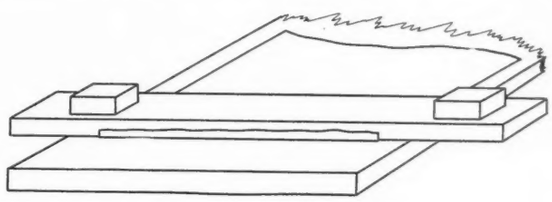


Fig. 22. Mounting Tracing Paper.

taken off the board and a clean white sheet not so large put in place of it. The tracing paper, being turned over, is again mounted to the board as previously described, care being taken to get no paste inside the cutting-off line, which should have been distinctly marked. While the paper is drying the colors can be mixed. Allow the coloring to thoroughly dry before cutting off the tracing, which should be done with a sharp knife, following the cutting-off line very carefully.

Mounting Cloth for Tracing or Coloring.—The process described above is for paper tracings only. Cloth can be mounted in the same way except that on no account should a damp sponge touch it, but it may be stretched without damping it at all, though not so satisfactorily. If the tracing cloth is put in a cold or slightly damp place over night it can be stretched very nicely, using a thin glue instead of paste. When one edge is firmly fixed, the other should be pulled very tight and extra weights put on the straightedge to hold it in place while applying the glue brush. Mounting for coloring is done the same way, it being, of course, understood that the coloring is done only on the dull side of the cloth.

Very satisfactory results can be obtained by not mounting tracing cloth at all, but simply using a number of iron tacks driven with a magnetized hammer elsewhere described.

Mounting Blueprints, Maps, etc.—Blueprints, maps, draw

ings, old tracings, etc., are often mounted on linen or cotton to preserve them. The linen or cotton should be cut larger by several inches than the blueprint and a drawing board about the same size used. Soak the linen well in water, rinsing it out between the hands until all the superfluous water is squeezed out, when it should be unfolded and shaken out. Lay it across the board and commence tacking one edge, beginning at the center and pulling gently; place a tack about every two inches along the edge of the board, as shown in Fig. 23. The other half of the same edge must be done in the same manner. The opposite edge is done next, stretching the linen well each time before a tack is driven; commence at the middle as before and work toward each end. The two remaining edges are done in exactly the same manner, and all is now ready for the paste, which should be prepared for use before the linen is stretched. The paste can be made either of starch or flour. A sufficient quantity is mixed in cold water to about the thickness of cream. Hot water is then poured over it, gently stirring it meanwhile; the whole is then put back into the saucepan and stirred until it begins to boil over, when it is lifted from the fire, poured back again into the basin, and is ready for use. An apron of some kind is fastened around the neck reaching to the knees to protect the clothes from getting soiled. Taking some of the paste in the hand, slap it over the board, rubbing it well into the linen with both hands, using more paste if required until the whole surface is covered. Now, commencing at the lower edge and at the left-hand end, holding the tips of the fingers close together push the superfluous paste along to the center of the board as you travel along from left to right. Go to the opposite side of the board and do the same thing, forming a ridge of paste along the middle of the board, which is scraped off with

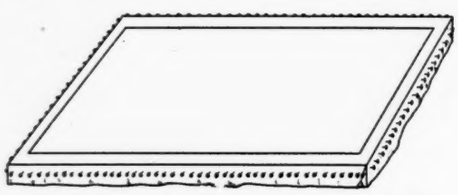


Fig. 23. Mounting Blueprints and Maps on Linen.

the hand into the basin. With both hands go all over the board again until the paste is nice and evenly spread all over the linen.

An assistant is now required. The blueprint is dampened on the back with a sponge and placed gently in correct position on the linen. One half is to be pasted at a time. The assistant holds it up by the two corners at an angle of about 30 degrees while with a large blotter in one hand held to the print you rub gently but firmly over it, the assistant letting the print gently yield to the pressure you bring to bear upon it. Passing over to the other half, it is lifted from the board and then treated in the same way. Wherever an air bubble appears it can be pricked with a needle, and the blotting pad placed over it, while with a circular sweep of the other hand you press it firmly to the board. Should any obstruction unfortunately have been left between the print and the linen a slit can be made in the former and the obstruction removed when it is again pressed to the board.

The whole should thoroughly dry before any attempt is made to tear it from the board. Often this is not done till the following day. Cut through the print and linen with a sharp knife along the cutting-off line all around the board. Then, lifting the corner, pull gently but firmly in a slanting direction. The tacks and trimmings are then removed and the board cleared away.

The case of a blueprint has been taken. Maps, drawings, etc., are done in precisely the same manner.

Before the print is taken up a coat or two of clear copal varnish is sometimes applied to preserve it still more.

Mounting Paper to Drawing Board.—A quick and very satisfactory way of mounting drawing paper to the board instead of using tacks is resorted to by many draftsmen in the following manner:

The paper is laid flat on the board, right side up. A moderate sized sponge filled with water is wiped all over the surface of the paper within an inch or so of the edge all around. The superfluous moisture is mopped up with the sponge and the edges then dampened.

One half of the sheet is turned precisely over the other half, edge for edge. With a well-filled mucilage brush go quickly around the three edges of the upturned half of sheet, and turning it over again, press the edges firmly to the board with thumb or a flat, thin stick. Turn the other half of the sheet over the first and proceed in the same way. When thoroughly dry the paper will stretch very satisfactorily.

Still another way of mounting paper is to lay the sheet down *wrong side up* and with a small glue brush dipped in liquid glue go all around the edge of the paper at once. Quickly sponge all over the surface with plenty of water, keeping clear of the glued edge. Having mopped up the superfluous moisture with a dry sponge, turn the paper completely over and stretch it to the board by going over the surface with the flat of the hand or a clean, dry duster, working from the center to the edges, pressing the latter all around firmly to the board with the flat of the thumb or a thin, flat stick or ruler.

Either of these methods has been successfully used in many offices, especially architects, but for important work the method described under the head of "Mounting Tracing Paper" and illustrated in Fig. 22 should be resorted to.

* * *

THE APPLICATION OF FOUNDRY BLOWERS.

The general application of a pressure blower of the fan type to a cupola is too well known to require description; but certain features which relate to its efficiency often escape attention. The proportions of a pressure blower wheel should theoretically be such that its capacity area or square inches of blast shall be practically equal to the free area through the fuel and iron in the cupola, less the influence of the resistances of piping, tuyere boxes, fuel and iron. These resistances are evidently the equivalent of just so much reduction in area, and must therefore enter into any consideration. But it is manifestly true that differences in the length and arrangement of piping in different plants, and of size, quantity and character of the charges in the same plant, introduce such variable conditions that it is impossible to design a blower of any type that shall at all times be just *exactly* proprotioned to the work to be done. For this reason the exact power required to operate any given blower cannot be given as an absolute quantity, but can only be determined when all of the conditions are known.

It is, or at least it should be, customary in specifying the pressure required to operate a cupola, to refer to that in the windbox. On the other hand, the table of blower speeds presented in the authoritative catalogues published by the B. F. Sturtevant Co. gives the number of revolutions necessary to produce the given pressure at *the fan outlet* when its area is within the capacity of the blower. Owing to losses due to transmission, this pressure cannot be maintained at any more or less distant point, such as the windbox of the cupola, unless the speed of the fan is increased sufficiently to produce an excess of pressure equal to the transmission loss.

It is the failure, on the part of the purchaser, to comprehend this fact, and to make due allowance for transmission losses, that sometimes results in too low a pressure at the cupola, and in unjust charge against the blower. Large, straight and short connections from blower to cupola are always imperative if waste of power is to be avoided. If changes in the direction of the piping are necessary, they should be made with as large a radius of curvature as possible. It should be distinctly understood that the power required to operate a fan blower is proportional to the area of discharge. If this area be reduced to zero, by the closing of the blast gate, the power will be reduced to merely that due to friction of the machine and the air confined within the case. Too often it is claimed, by those who ought to know better, that closing the pipe increases the power; but, as power is expended only when air is moved, the fallacy of this statement is evident.

SHOP PHOTOGRAPHY.

H. P. FAIRFIELD.

One of the most valuable and interesting phases of picture-making with the camera is what is commonly termed "shop photography"; that is to say, pictures of machinery either in operation or under construction. Where a machine is photographed for catalogue purposes it is usually painted and posed for the occasion and can be put in a selected light. Such work as this does not properly come under the head of shop photography, but is true machine portraiture.

Technical publications, such as MACHINERY, are making an increased use of shop photographs, and no small part of their popularity is due to the willingness to use camera results. How firmly a picture fixes a result in your mind! Take for example a "Weak Steam Fitting," shown on page 486 in MACHINERY for May, 1906. The eye catches this at once, and it is doubtful if the reader can ever forget the result of a use such as described. Besides this, it has called his attention to what he may expect under like conditions. Along this same line may be noted perhaps hundreds of similar cases where the camera has fixed for the readers a record of some device or called attention to some happening of general interest and value. As an example of what the camera has done for the manufacturer, consider the advertising matter of, say, the Cincinnati Milling Machine Co. In such cases as this the photographs represent the manufacturers' own practice and only what may be viewed direct by a visit to his works, if this were possible.

In machine construction of certain kinds, the camera tells the story of progress to those interested as no other means can, and many firms use such records on work being built or erected or going forward away from their immediate view. The Brown Hoisting Mchy. Co., of Cleveland, Ohio, are a notable example of this use of "shop" or "record of fact" photography.

The writer's use of the camera began about fifteen years ago with the taking of several views of a wreck due to a flywheel explosion in a wire mill, and has continued with increasing interest till the present time. Photographs have been sought wherever anything novel occurred, where machines were in use, and, in fact, whenever a record of fact was desired. Examples of old and interesting machines have been sought and recorded, and in this manner the progress of the designer's art is shown.

To the readers of MACHINERY it is probable that shop photography is most interesting from the aspect of its application.

First: For purposes of illustration and explanation relative to what may be expected under actual working conditions.

Second: Progress of construction or erection. To achieve satisfactory results in either field requires a good outfit and much careful, painstaking work.

In no other line of camera work will conditions relative to a proper lighting of the subject be worse than are often found in shops, when one considers that the exposures must be made just as things are found. However, satisfactory results can be obtained under any and all conditions by the exercise of good judgment and a knowledge of all the ins-and-outs of photography.

The pages of technical publications show that nothing is too difficult if the object is worth attainment. Pictures are seen which have been made with the camera set on the cylinder of a steam engine, on the running board of a locomotive traveling at high speed, under mills with the camera set on thin ice; in fact, no place is too hot or too cold for the ambitious worker—"the man behind the gun"—if he is provided with a suitable outfit.

A camera that will produce negatives of a size ranging between 5 x 7 inches and 8 x 10 inches is suitable for this work and should have a bellows draw that will permit the use of lenses with a length of focus equal to twice the *long* side of the plate used. For this purpose the writer prefers to use two cameras, one of 5 x 7-inch size and one 8 x 10 inches. The use of wide angle lenses must also be considered when the camera is purchased, as it should be possible to use lenses with a length of focus equal to or less than the *short* side of the plate used.

While the camera box is important, it is to the lens that we must look for the picture, and a good set of lenses is indispensable. A Zeiss Convertible VII. A. set is an excellent lens for the purpose, as the doublets are made up of two single combinations that are corrected for astigmatism, spherical abberation, and are rectilinear and practically perfect lenses each, when used alone. When used as a doublet the length of focus should approximate the long side of the plate they are used on and the single combinations should have a length of focus equal to one and one-half and two times the length of the long side of the plate. In addition to these, a doublet with a length of focus equal to, or less than, the short side of the plate should be provided. These should all be fitted to interchange in a good "between the lenses" shutter, provided with a bulb and tube sufficiently long to permit standing a convenient distance from the camera while making the exposure.

The picture depends, to a great extent, upon the viewpoint from which it is taken, and the length of focus of the lens used. If the machine is taken broadside on, the effect is usually grotesque, and the same may be said of strictly end views; however, as the operation or construction to be photographed will seldom admit of a choice of views, it becomes largely a question of which lens to use. To this end, bear in mind that the shorter the focus of the lens used on a particular plate, the more the perspective is magnified, and *vice versa*, the longer the focus the more nearly correct is the perspective.

Little can be done relative to lighting, as the light must usually be taken as found; however, at times, a choice is possible, and something may be said on this point. Bear in mind when setting up the camera: *a*. That the light should not come from the front, but from behind. Strong light in front *must* be screened off. *b*. Strong light from any point is to be avoided, as it begets heavy shadows, and a dull or rainy day is to be preferred to brilliant sunshine, unless some means for screening the windows is provided. *c*. That the light which enters the lens should be reflected light coming from the surfaces photographed, and that the dark surfaces and shadowed portions reflect but little actinic light. Use double-coated, non-halation plates, expose for the shadows and develop with a pyro developer, at least until you become an expert operator. Study your negatives and prints for the lighting, the effect of the perspective, the length of exposure given, and the development. Keep at this until you know a good negative when you see it, also how to produce such a one; study the picture upon the ground glass when selecting the view point and lens to use, as that represents the way the lens sees it.

As a short summing up, the description of an outfit that has been in use for four years and was bought after considerable experience with various combinations, may place the subject before the reader most clearly. The camera box is known as a 5 x 7-inch, and has all the usual adjustments, with a bellows sufficiently long for any of the lenses of a No. 8 Zeiss convertible lens ground by the Bausch & Lomb Co. Used as a doublet, the focus is 7 inches; front combination, 14 inches; back combination, 11½ inches; which interchange in a Bausch & Lomb shutter lens of 4¾-inch focus. The tripod is of the single-slide type, heavy enough to be rigid and stable under severe conditions, even when used to carry an 8 x 10-inch box. This outfit is practically duplicated in the 8 x 10 size, as a 10-inch focus lens is used upon an 8 x 10-inch plate and a 19-inch focus wherever the conditions will permit. A study of camera catalogues will teach the user that there are many helps in the line of simplifying his labors if his means will allow of their purchase. For instance, a flash-lamp outfit is a great help in dark situations, but it needs to be used with good judgment and a knowledge of its limitations or the results will be grotesque. Do not buy an advertised help until you know something of it, and then only when you can see its value in your own work. Study up on lighting, chemistry of the developing and printing processes, the design, construction, and physics of photographic lenses and ever stand ready to honestly compare your work with that of other workers, aiming at improvement always.

PORTABLE TOOLS FROM EUROPE.

Portable tools have been brought to a high state of development in Europe and are widely used for general manufacturing. Advantage has been taken of the electrical drive

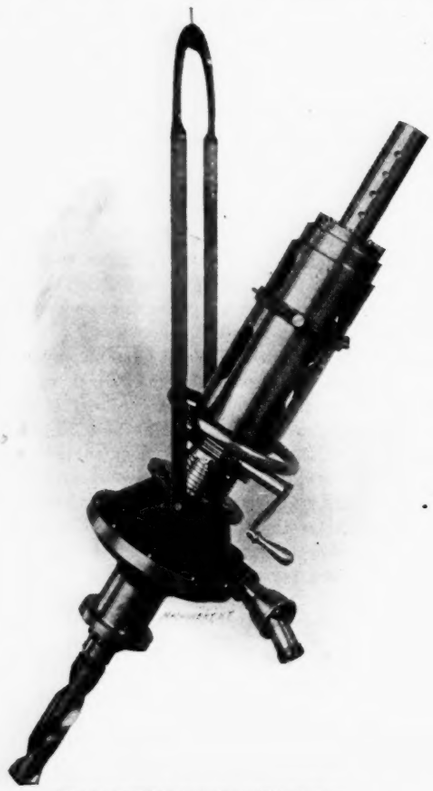


Fig. 1. Drilling Spindle without Base.

in many ways, for various purposes and with the leading idea to reverse the ordinary practice; instead of carrying heavy work to the machine tools, where it has to be set up and fastened for machining and removed again after the work is done, effective tools working with utmost precision are brought to the piece and attached to same, the machining is done with or without jigs in one setting. This always saves time and in a great many cases operations can be performed with these tools that would otherwise require special and costly machines.

It was the general custom to use portable tools only in places where no other means were available, where a bracket

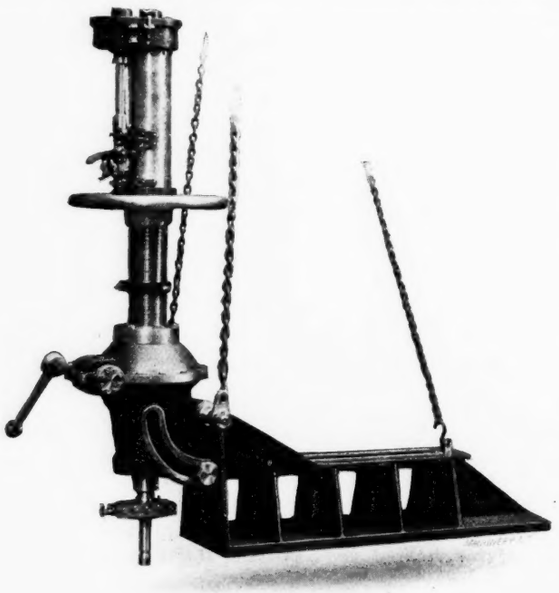


Fig. 3. Capitaine large size Portable Milling and Drilling Tool.

or similar part had to be attached which was not provided for on the drawing and in other such instances. With the European tools it is different, they count just as much in the process of manufacture as any stationary machine with the only difference that they are more adaptable.

The milling and drilling tools illustrated consist mainly of a work spindle, driven by means of a telescopic shaft from a portable electric motor. This spindle may be clamped to a jig or to the work itself by means of a very simple device. Fig. 1 shows a drilling spindle suspended; Fig. 2 a drill spindle clamped to a slotted base. A series of holes is drilled into a flat plate, by clamping the base *A*, Fig. 4, to the plate by means of a screw-clamp *c* and after

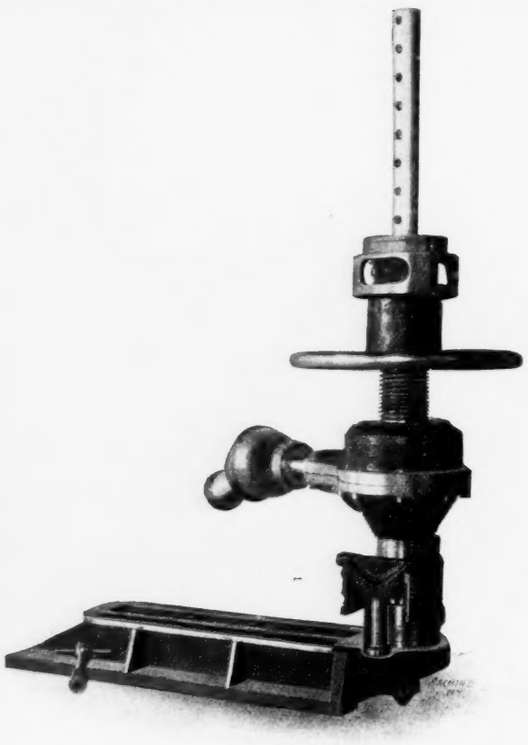


Fig. 2. Drilling Spindle Clamped to Slotted Base and provided with Extensible Drill Spindle.

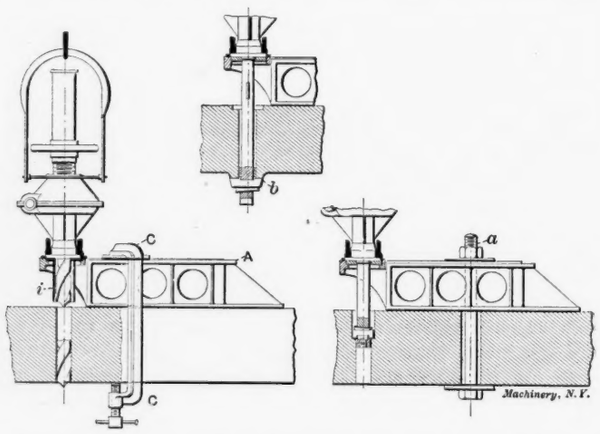


Fig. 4. Showing Use of Tool with Guide Bushing for Accurate Drilling; also Counterboring and Back Facing.

one hole is drilled this is used to hold the base with a bolt. From the illustrations can be seen that the drill is guided by a suitable bushing *i*, close to the hole, which in combination with the flat base *A* insures a perfectly true and accurate drilling. The same cut shows in the upper view how bosses inside of side frames may be finished with the same appar-

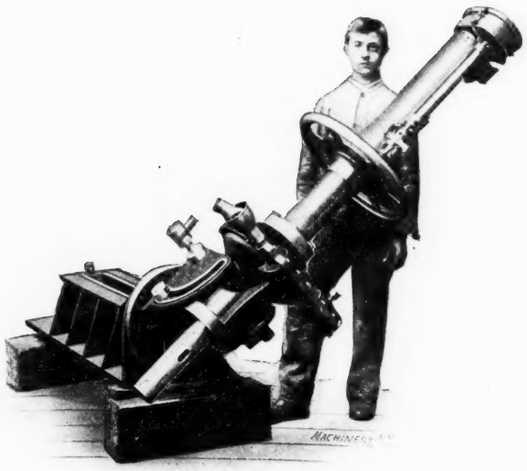


Fig. 5. Large Size Portable Milling and Drilling Tool.

atus. When very deep holes are to be drilled, or the hole, which is to be drilled is some distance away from a suitable place for clamping the base, the drill spindle can be lengthened indefinitely, by moving a pin in its upper end from hole to hole, as may be seen from Figs. 1 and 2. The larger portable spindles are provided with automatic feed and stop, which permits drilling or milling under any angle. Figs 5 and 5*a*, which illustrate this, also illustrate to what large dimensions these tools are built. Fig. 6 is the same tool at work drilling a big dynamo frame. These large sizes are suspended and balanced, but the smaller ones can easily be lifted by one man.

A few more illustrations will show the general adaptability of the system. A special base with slide-rest is provided for milling seats with toothed or other milling cutters, Fig. 7, and clamping one of the larger spindles to it. By providing two upright posts on a floorplate, Fig. 8, it serves as an efficient horizontal boring machine. Fig. 9 shows a portable spindle clamped to a jig, *c*, for drilling the holes *b* and milling the valve seats *a* in one operation.

Another application of this system of portable tools is the boring of large cylinders. The boring bar of Fig. 11 is principally used for boring locomotive cylinders in place; it may be used for any length of cylinder as the spindle length is unlimited. The feed and stop are automatic, by means of two rollers pressing against opposite sides of the boring bar;

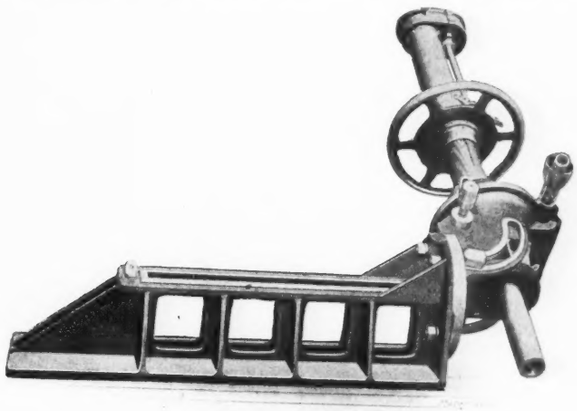


Fig. 5a. Large Size Portable Milling and Drilling Tool.

these are driven by a worm gear. Figs. 10 and 12 show a similar tool for boring and facing gas engine cylinders.

A special tool for milling steam ports in Corliss engine valve chests and which also is driven by a telescopic shaft and electric motor, is illustrated in Figs. 13 and 14. The

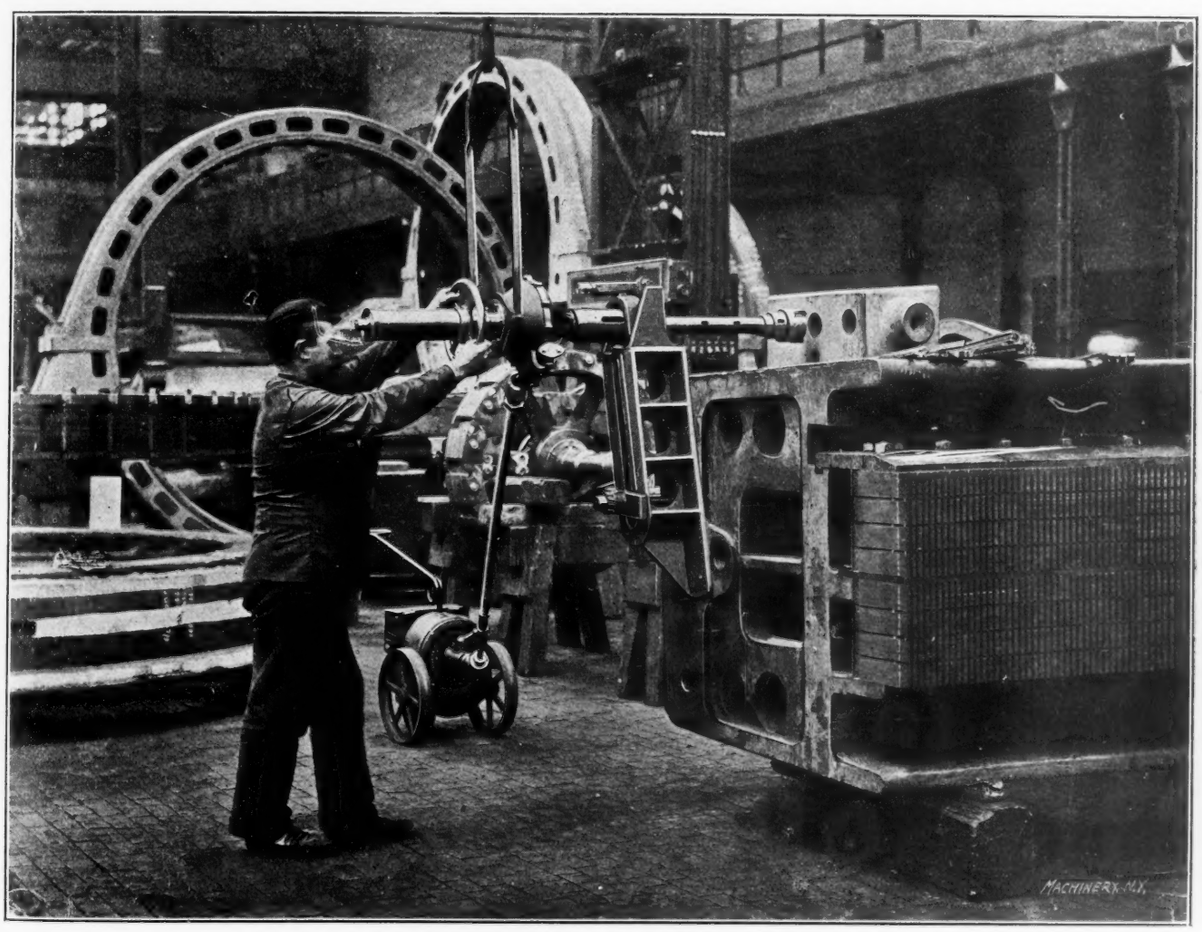


Fig. 6. In Use Boring Holes in a Large Dynamo Frame.

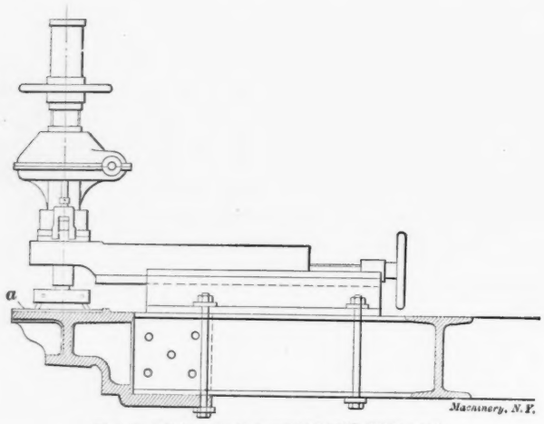


Fig. 7. Milling Tool provided with Slide-rest.

carriage *B* moves in the groove of the tube *A* automatically, being driven by spindle *D* and a sliding helical wheel which meshes into the pinion on the milling spindle *C*. The transverse adjustment is accomplished by a long wrench *p* from the outside, turning shaft *o*, which transmits its motion by a worm and wheel to the adjusting screws *c* and *e*. The parallel milling of the ports is secured by two eccentric discs *E*, which fit into the bore of the valve chests.

There are many more applications of these tools for special purposes, of which we have shown a few. The designers and builders of these tools are Messrs. Emil Capitaine & Co., Frankfort-on-the-Main, Germany, and Mr. M. Joachimson, 14 Church Street, New York, is their American representative. The De La Vergne Machine Co. recently installed a number of these tools in their shops and others are in preparation.

* * *

A new bridge of imposing dimensions will be built across the St. Lawrence river at Montreal in the immediate future. It will be a cantilever bridge with a main span 1,500 feet long, 150 feet above the water. The bridge will have accommodation for railway and trolley tracks, as well as for horse and passenger traffic. From end to end the bridge will be two and a half miles in length.

* * *

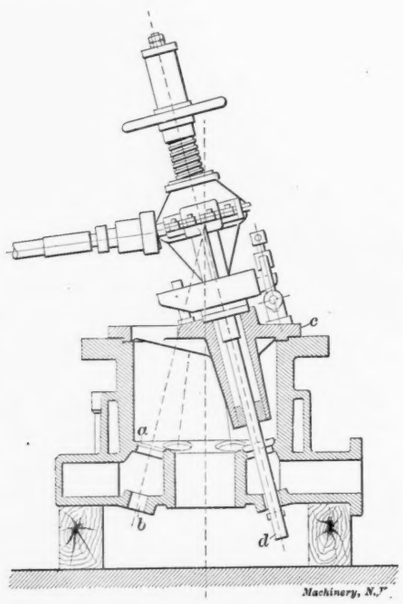


Fig. 9. In Use in a Jig, Boring and Milling Valve Seats at an Angle.

TECHNICAL EDUCATION IN EUROPE.

In his article "An Experiment in Industrial Engineering," in the September issue of MACHINERY (Engineering Edition), Mr. Alexander expresses the belief that the efforts which the General Electric Co. and other concerns are putting forth to train boys in various trades, must be considered "as experiments only, highly important as an immediate remedy; but these are experiments which the state ought to watch with a deep interest, in order to draw therefrom proper conclusions as a foundation on which to build the right system of industrial education." He expresses his belief that the public school system should adapt itself to modern industrial conditions by at least starting boys, who are to work with their hands for a living, in the way of gaining familiarity and efficiency in the handling of the tools which they are to employ when they leave the school and enter the factory. The extent to which this idea has been carried in some continental countries is a matter of record. We were given a

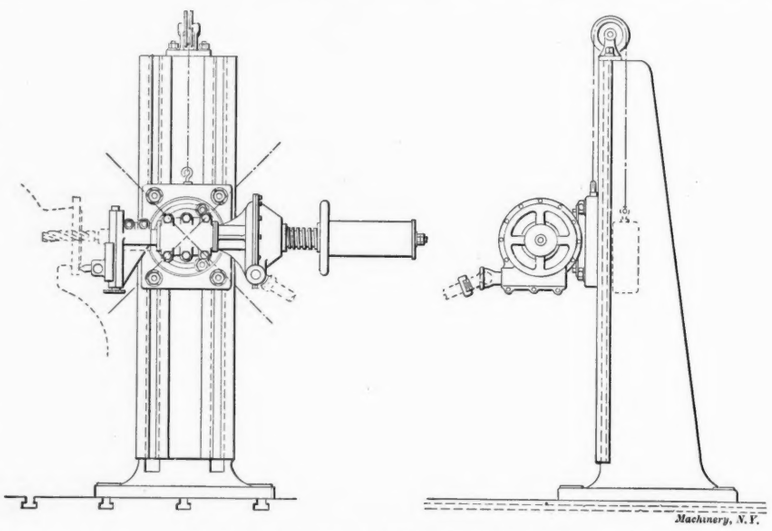


Fig. 8. Use of Portable Tool as a Boring Machine.

fresh and vivid impression of this condition, however, in a recent conversation with Mr. Arthur Williston, the director of the Department of Science and Technology in Pratt Insitute. Mr. Williston has just returned from an extended visit to the various trade and technical schools of Europe.

The population of Switzerland, for instance, is 3,315,000; that of Massachusetts is slightly over 3,000,000. Switzerland, which we are accustomed to think of as primarily a land of wild mountains and unfertile soil, with the fleecing of tourists as its chief industry, has within its boundaries over 300 technical schools of various grades. The data for the

Fig. 13. Portable Tool for Milling the Ports of Corliss Engine Cylinders.

number in Massachusetts are not at hand for the moment, but whoever is at all acquainted with this most highly developed of our manufacturing commonwealths would hesitate to put the number at more than 10 or 15 per cent of that given for its European rival. The figures given for Switzerland include, of course, institutions of all grades—trade schools, elementary and higher technical schools, and engineering colleges. One of these latter, the Polytechnikum of Zurich, compares in equipment and number of students with our

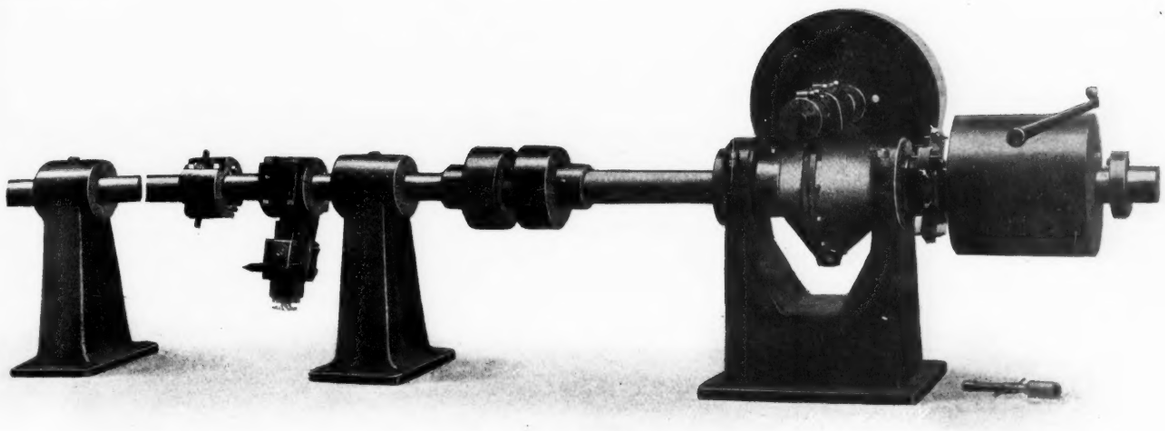


Fig. 10. Portable Boring Machine for Gas Engine Cylinders.

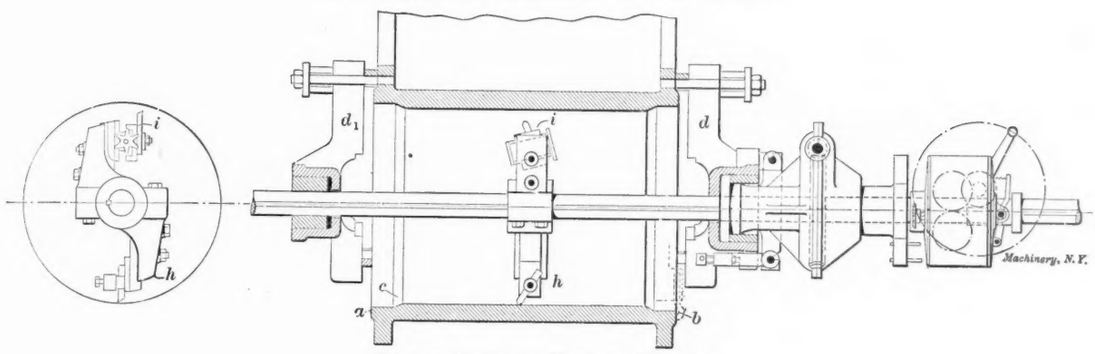


Fig. 11. Capitaine Portable Boring Machines

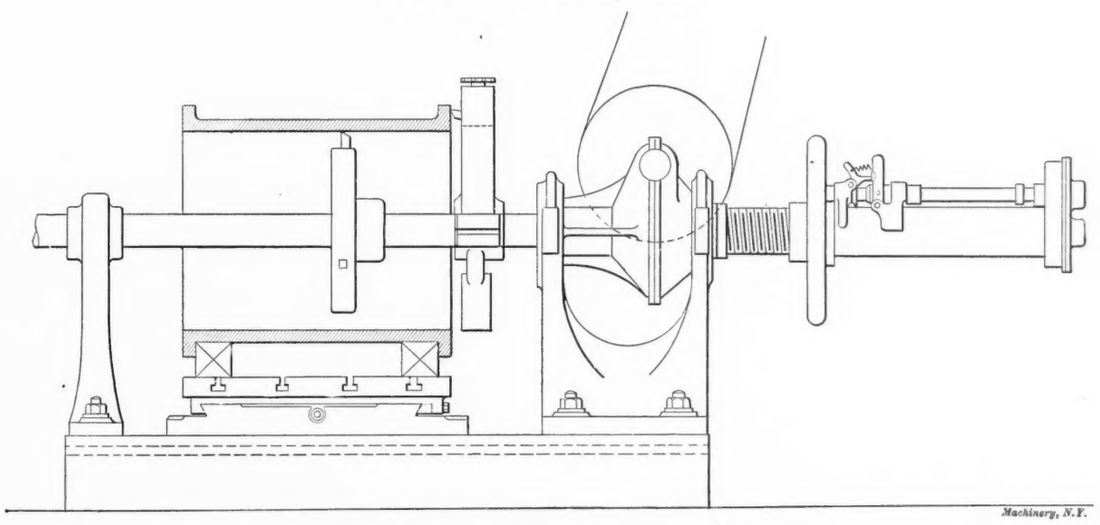


Fig. 12. Portable Boring Machine for Engine Cylinders.

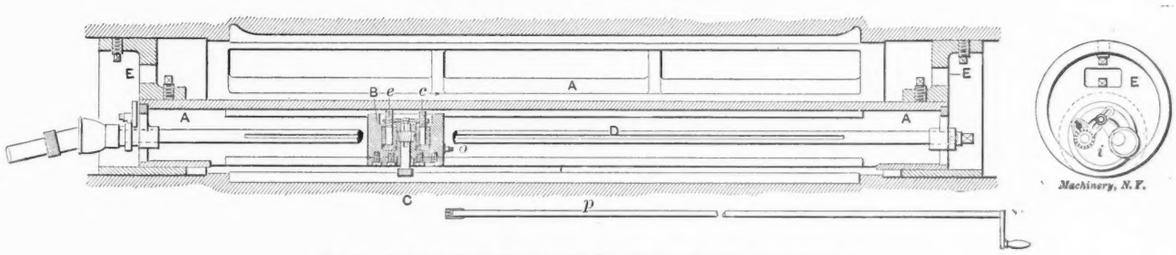


Fig. 14. Detail of Portable Tool for Drilling Corliss Engine Cylinders.

great engineering schools, and ranks with the Massachusetts Institute of Technology in the excellence of its work. With this as the culminating point, the list, widening as it descends, embraces schools of various characters of the grade that Mr. Williston calls "technical schools," of which Pratt Institute and a few others are the only representatives in this country. Of these Switzerland has many; they prepare men for foremanships, positions as mechanical and architectural draftsmen, etc. Below this rank come the elementary technical schools and the trade schools. Some of these are of great size and

wide reputation, while others teach but a single trade and have perhaps only a single instructor, being located in the midst of the district employing the class of labor which the school is intended to furnish. One of those visited, a cabinet-maker's school, had only one instructor and twenty-five or thirty boys, but the artistic quality and finish of the work turned out, most of which was designed as well as executed by the students, was really marvelous. Institutions of this kind are almost unknown in this country; except for the small horological schools which are to be found in some of the watchmaking centers, we cannot call to mind an American parallel. Descending to the lowest grade, the elementary trade or industrial schools are found everywhere. Boys in the towns learn to use tools with the same facility that American children are taught to reckon interest on promissory notes, and this is done without sacrificing much of what we consider necessary to the boy's education.

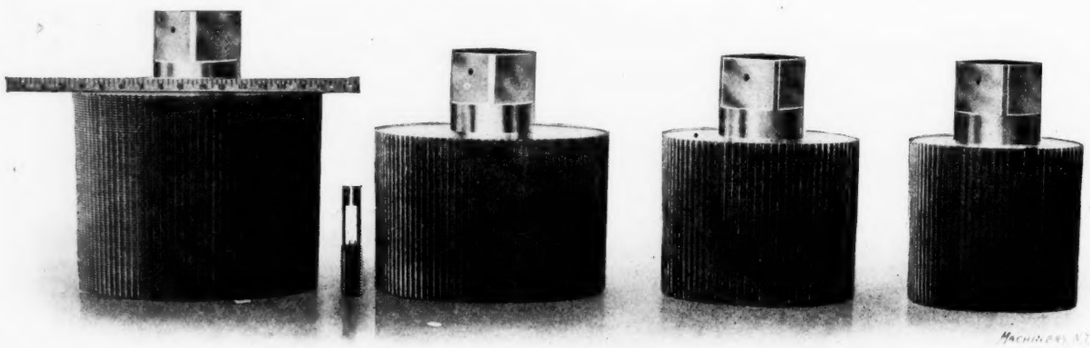
The still more highly developed German system of instruction provides for the "continuation school." When the boy is graduated from what corresponds to the grammer school he has two paths open. He may, if he possesses the inclination and the moderate means necessary, continue his education in the higher technical schools with the idea of becoming an engineer; or he may leave school and go to work in a factory, serving an apprenticeship in some trade. If he chooses the latter course, however, he is not by any means through with his education. He is required by law to attend this "continuation school' held evenings for six days in the week, usually, with five hours on Sunday. This lasts from two to four years longer. His time is largely taken up with subjects having some bearing on his business during the day, so it all makes toward his efficiency as a workman. The result of this completeness of education might possibly be somewhat disquieting to an American young man, arousing in him ambitions which there would be no opportunity to fulfill. Whether this would be so here, or not, in Germany with German workman it is fast bringing that country to the premier position in industrial competition. All the work which these engineers, draftsmen and mechanics are doing has to be done under any circumstances, and the question is, shall it be done by men who know merely the barest superficial rudiments of the business they are engaged in, or shall it be done by men intelligently educated, even over-educated, for the work they have to do. In Germany they have chosen the latter alternative and they seem to have chosen wisely.

* * *

LARGE HOB TAPS.

The accompanying halftone shows a series of taps which in all probability are the largest hob taps ever manufactured. These taps were recently made by the Pratt & Whitney Co., Hartford, Conn., and are to be used for oil well casings. The two largest taps in the series measure 12 and 12¾ inches in diameter, respectively. The threaded portion of the largest hob tap is 10 inches long, and has eight threads to the inch. This tap is provided with 104 flutes, the land and the flute being each about 3-16 inch wide, and if the tap were forced entirely through a piece of metal, it would thus present to the work more than 8,000 cutting edges. The total weight of this tap is 357 pounds. For comparison, a 1-inch hob tap is shown on the side of the largest tap.

The manufacturing of these taps presented, of course, no new principles, but that difficulties were encountered, particularly when hardening these large pieces of tool steel, is easily apprehended. The successful performance of the hardening operation is indicative of the efficiency of the methods employed in the manufacture of "small" tools on a large scale. In this connection it may be appropriate to mention that during the last few years the size of "small tools" has increased decidedly, and that many a time the name does not seem to suit the object. Inserted blade milling cutters, 30 inches in diameter and even larger, and gangs of interlocked cutters with 40 inches width of face are frequently encountered. The introduction of large size milling machines has made the requirements for a different type of milling cutters than those used only a few years ago imperative, and in almost all the branches of the small tool manufacture there is a tendency to increase the sizes of the tools used above the limits of former years.



Large Hob Taps.

THE ULTIMATE DEVELOPMENT OF THE AUTOMATIC MACHINE.

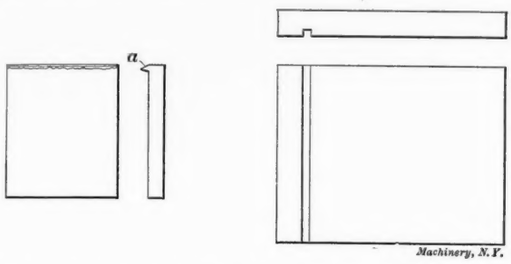
When describing a visit to a typewriter factory, a cotton mill, or any other place where automatic machinery is in evidence, the magazine writer always speaks of it as possessing "an intelligence almost human." What the possibilities are in the development of these machines toward the point where they will think for themselves, it is hard to say; even now they may be arranged to perform selective functions, guiding their action in accordance with the momentary condition of the materials they are working on. Many years ago Bulwer Lytton, in his book, "The Coming Race," suggested the possibility of the time when the problem of social inequality would be solved by the employment of automatons as servants, these mechanisms being guided by the telepathic communication to them of the desires of their masters. Perhaps this is an idle dream, but the writer lays claim to having discovered in an automatic machine an approach to one, at least, of the attributes of a human being—conscience. Each evening in returning home from the office he is confronted by a penny-in-the-slot chewing gum machine which has tempted him more than once to try the result of inserting a coin in the opening, with the hope of obtaining value received for what he has given up. He has been invariably disappointed in this experiment. The other evening as he stood glowering at the machine, soured by the memory of past misfortunes, his imagination could almost conceive that it was writhing under the withering scrutiny. Giving the plunger a vindictive jab, merely to express his feelings, without putting in the cent as on former occasions, what was his surprise to see the panic-stricken machine shoot a chocolate caramel out at him through the opening, and then—O, culmination of wonders! Two metallic tinkles, one after the other, announced the giving up of two of the numerous cent pieces which had been unavailingly surrendered to it from time to time. "Thus conscience doth make cowards of us all." May be the time is coming when this will apply to machines as well as to men.

DRILL JIGS.—1.

E. R. MARKHAM.

Drill jigs are used in drilling holes which must be accurately located, both in relation to each other and to certain working surfaces and points; the location of the holes is governed by holes in the jig through which the drill passes. The drill must fit the hole in the jig to insure accuracy of location. When the jig is to be used in drilling many holes, the steel around the holes is hardened to prevent wear. If extreme accuracy is essential, or the jig is to be used as a permanent equipment, bushings made of steel and hardened are used to guide the drills.

The design of a jig should depend altogether on the character of the work to be done, the number of pieces to be drilled, and the degree of accuracy necessary in order that pieces drilled may answer the purpose for which they are intended. When jigs are to be turned over and moved around on the drill press table they should be designed to insure ease and comfort to the operator when handling, and should be made as light as is consistent with the strength and stiffness necessary. Yet, we should never attempt to save a few ounces of iron, and thereby render the jig unfit for the purpose we intend to use it. The designer should see that the jig is planned so that work may be easily and quickly placed in and taken out, and that it can be easily and accurately located in order to prevent eventual mistakes. As it is necessary to fasten work in the jig in order that it may maintain its correct position, fastening devices are used; these should allow rapid manipulation, and yet hold the work securely to prevent a change of location. Yet, while it is necessary to hold

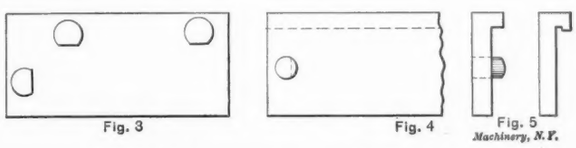


Figs. 1 and 2. Work with Burr and Grooved Part of Jig to correspond.

work securely, we should not use fastening devices which spring the work, or the holes will be not only improperly located, but they will not be true with our working surfaces or with each other. When finishing the surfaces of drill jigs and similar devices used in machine shops, the character of the finish depends entirely on the custom in the shop; for while in some shops it is customary to finish these tools very nicely, removing every scratch, and producing highly finished surfaces, in other shops it is not required, neither is it allowed, as it is considered a waste of time and an unnecessary item of cost.

When making drill jigs we must discriminate between measurements that must be *exact*, and those not requiring extreme accuracy; it is not generally allowed to spend the amount of time necessary to locate a hole within a limit of variation of 0.0001 inch or even closer, if a variation of 1-16 inch is insignificant. But if the holes must be located *exact* as to measurements, it is necessary to work as accurately as possible, and time cannot be considered a factor, provided a man improves every minute. Yet the fact that extreme accuracy must be observed does not warrant a jigmaker *wasting time*.

Before starting to work on tools of this character, the workman should first carefully look over his drawing, making himself thoroughly familiar with the construction, and making sure that the measurements given are correct; if in doubt about anything, consult the foreman, or the draftsman—according to the custom in the shop—in order that every detail may be thoroughly understood, or that any mistake made in the drawing may be rectified. A very poor policy is carried out in some shops. The drawing department and the shop seem to be at "loggerheads" with each other, and are constantly on the lookout for points on which to trip each other. This condition should not be allowed, as both departments are paid by the company to work for the interest of the firm, and not to hunt for chance to harm each other; and if best results are to be attained, there must be a correlation of departments, which condition cannot exist where there is jealousy or a desire to harm one another. The draftsman should always be ready to give any information wanted in the shop, and should also gladly correct any errors his attention is called to. I remember at one time a draftsman's attention being called to an apparent error in a drawing; instead of explaining matters to the toolmaker he informed him that his only concern lay in making the piece he was working on exactly as the drawing called for, and if it proved wrong it was none of his—the workman's—affairs; he was paid simply to follow instructions, and it was the business of the drawing room to give the necessary instructions. In making



Figs. 3, 4 and 5. Means for Locating Work in Jigs.

the drawing the draftsman had, in order to save time, shown several screws as being without threads; they were made of the proper size and length, with slotted heads, yet without threads, the draftsman knowing that the toolmaker would know what was wanted. The latter, however, was offended, and in order to get square for his recent snub he made the "screws" as represented on the drawing, fitted them to the holes and drove them home. When it was discovered, and he was questioned about it, he told what the draftsman had said to him, and said he had followed his instructions implicitly. I need not tell you that he was discharged, and think every fair-minded man will agree that he should have been; but I think the draftsman should have been made to go with him for creating a feeling of antagonism rather than of good will toward himself. Many times one draftsman is puzzled to understand a drawing made by an equally good man, especially so if the work is foreign to him; and a shop man who may not be very well versed in reading drawings—yet be an excellent workman—may easily get puzzled when he attempts to read a drawing of work he is not familiar with.

While the above does not relate to toolmaking in the strict sense of the term, yet it seems advisable to speak of it, as the condition is altogether too common.

It is necessary when designing tools of any character, whether they be cutting tools or fixtures for holding work while machined, to make provision for the chips. These are

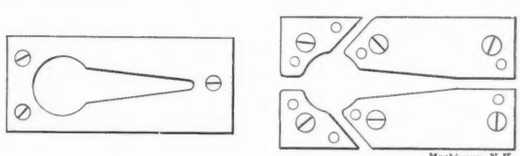


Fig. 6. Method of Locating Work in Jigs.

liable to get into drill jigs, and despite ordinary care get under the work or between it and the locating points. In order to do away, so far as possible, with this tendency, it is advisable to cut away as much of the seating surface as can be spared, and to locate stops away from the seating surface if possible. The seating surface should be smooth enough so that chips will not adhere to it, and so that waste will not stick to it, but it should not be a polished surface, as we would in all probability get it out of true if we attempted to polish it. If chips are allowed to get under the work it will not be drilled true; that is, the holes will not be at the proper angle with the working surface, and consequently the piece will be unfit for most purposes.

Many operations of machining are almost sure to throw a burr on one side of the piece, and in shops where quantities of work of the same kind are machined, men or boys are kept

busy removing these burrs in order that they may not interfere with the proper seating of the pieces during the succeeding operations. While the operation of removing the burr on a single piece of work may not incur great cost, yet when thousands of pieces are machined each day, the aggregate cost constitutes quite an item of expense, and the successful manager is he who so far as possible eliminates the small items of expense, knowing that many small items of expense amount to a large item in the aggregate. Not only is the operation of burring expensive, but as the class of help usually employed to do this work is unskilled, surfaces are many times left in a condition anything but satisfactory. As a consequence, the surfaces of jigs, milling machine fixtures, etc., are many times cut away to receive these burrs, thus doing away with the necessity of burring, and it many times happens that subsequent operations remove the burrs. In Fig. 1 is shown a piece of work having a burr thrown out at *a*, while Fig. 2 represents a surface cut away to receive the burr.

When we wish to drill two holes a given distance apart, the location of the holes is obtained by means of a pair of dividers set to a scale. The location is obtained and prick punched, after which the holes are drilled. This method answers nicely when one piece is to be drilled, and precise measurements need not be observed. If it is necessary to drill ten thousand pieces, then this becomes a costly method and the work can be done more cheaply if a jig is made to hold the pieces. The jig must, of course, have holes the size of the drill, which are properly located. By the use of the jig the cost of drilling is but a fraction of what it would be if the holes were located by dividers, and the surface prick punched as described.

A factor which must be considered is the cost of the jig. If the cost of the jig plus the cost of drilling would exceed the cost if the pieces were first prick punched and drilled as formerly described, then the making of the jig would not be considered unless a greater degree of accuracy was necessary than would be liable to be the result of the method mentioned. When a jig is to become a permanent part of the equipment of a shop, its first cost is not so much a matter of consideration as when only a limited number of pieces are to be drilled. Yet no unnecessary expense should ever be allowed.

Many times when only two pieces are to be drilled which must be exactly alike as regards location of holes, it is cheaper to make a simple jig than to attempt to drill them by any of the methods commonly used in machine shops. In such a case the jig may be made from a piece of cast iron or other material which may happen to be on hand, the holes being carefully laid off and drilled. This jig makes it possible to drill the holes in both pieces exactly alike as to location. When using a jig of this description it is possible to locate the holes near enough for most work by ordinary measurement. If many pieces were to be drilled, it would be necessary to provide locating points so that the pieces could be placed in the jig, and the essential surfaces brought against these. The means of locating may be pins, as shown in Fig. 3, or a shoulder and a pin, as in Fig. 4. If pins are used, they should be so located that the bearing surfaces may be worked flat, as shown, to prevent wear, and also to do away with a tendency to press into the surfaces of the work. If flat shoulders are used they should be cut away, as shown in Fig. 5, to do away so far as possible with a liability of dirt or chips getting between them and the work. Then, again, if the working edges of the pieces of work are not exactly true, it would be impossible to properly locate by pressing them against true locating surfaces which extend the whole length.

When work is of irregular contour that could not be properly located by bringing it against two locating surfaces it is possible to provide a locating device which bears against all the surfaces, as shown in Fig. 6. This method, however, is hardly to be advocated for most work, as it necessitates exactness of measurement and shape on all the bearing surfaces. Then, again, the shape makes it extremely difficult to clean, and a chip under any portion of the work will cause it to stand at an angle with the seating surface of the jig.

THE EXPERIENCE OF BEAUREGARD NAPOLEON FREDERICKSON WITH THE PROFIT-SHARING SYSTEM.

"THE HIRED MAN."

Beauregard Napoleon Frederickson called by his host of friends "Gardie Fredericks" in loving abbreviation, was, and is, one of the best fellows that ever laced a belt; this does not mean that he spent the money that should have been spent for his wife and babies in "setting them up" in bar rooms for his host of friends, nor on the other hand does it mean that he was afflicted with "the deadly dullness of the merely virtuous."

Gardie was a good mechanic, and alas! an inventor also; all of which wouldn't have been so bad, but he was, in addition to all these things, a sucker. How could he be a good fellow and a sucker, too? Why, bless your heart, I don't mean a sucker from a shop standpoint, but one of the kind that some classical writer has assured us is born every minute. So, being an inventor, he brought forth his celebrated "whirlwind whirligig" with a sort of "dusky diamond attachment," and having been born at the psychological moment aforesaid, it wasn't long before he was soon collared by Charlemont Worsley Hornswoggler, who, having been born at a

"* * * * all the profits made on the selling end of the business * * * * unable to figure any profit at all for the factory."

different minute from the subject of our sketch, could not only see through a hole in a ladder, but knew a good whirligig when he saw it. The result was that Mr. Beauregard Napoleon Frederickson assigned all his right, title, etc., in the whirligig to Mr. Charlemont Worsley Hornswoggler and to his heirs and assigns forever; in return for which Hornswoggler was to furnish a factory and machinery and other capital necessary to manufacture the whirligig, and give B. N. Frederickson a stated salary for running the factory and a share of the profits. (As Artemus Ward would say: "The printer must put some stars here.") * * * *

What is the use of going on? We have now reached what corresponds to the end of the third act of a play in a theater, and everybody can see how the last act will end. But as people usually stay to see the last act, and as the editor will probably refuse to give me the large check he has bribed me with to get this story, unless the story is finished, here it goes! When the things got to moving in good shape, and it seemed there ought to be a pretty good sized wad to spare, our hero borrowed a plug hat and went over to the city office to look it up. Mr. Hornswoggler told him that he had carefully figured the thing out, and found that, while there had been considerable money made, it had all been made on the *selling end* of the business, and that he had been *unable to figure any profit at all for the factory.*

THE VALUE OF "NON-PRODUCERS" IN MANUFACTURING PLANTS.

H. K. HATHAWAY.

The greatest fallacy that exists to-day in the minds of most proprietors and managers of manufacturing plants is the idea that if they keep down the proportion of so-called "non-producers" they are necessarily saving money; but in considering the subject of non-productive expense, they are so alarmed by the thought of spending money from which they can see no immediate tangible return, that they do not look beyond the surface; and thus they deceive themselves in the belief that they are acting wisely in curtailing the number of "non-producers," whereas, if the subject were thoroughly investigated, the opposite course would often prove the one to be followed. The object of this article is to represent the matter in its true light, and to show that mere "non-producers," if their efforts are properly directed and utilized, are in most cases, not only profitable but essential to economical production.

The term "non-producer" is generally applied to clerks, foremen, inspectors, helpers, and others, whose labor is not directly expended in transforming raw material into product to be sold; while those whose labor is so expended are classed as "producers."

A few years ago the writer was superintendent of a plant whose principal product was automatic steam engines; this concern employed about one hundred and twenty-five men, and had started in a small way about fifty years ago. It prospered and grew for about forty years, and then, for no apparent reason, began to slowly retrograde until finally it failed completely. To the end the product was of the same high standard of workmanship and design that had contributed to the early prosperity of the plant, having been improved from year to year to keep pace with the demand for something better, and to compare favorably with the goods put on the market by competitors. The business policy was unchanged, and the same methods of manufacture and management that had prevailed in the period of prosperity were still adhered to.

In this plant there was only one foreman, who kept track of all the work in progress, looked after the quality of the work, the discipline, and all other details connected with the operation of the plant. Each workman ground his own tools, and had them dressed when necessary; repaired his own belts, and took care of the appliances used by him. Only two or three laborers or helpers were required, as the men helped each other in getting work to and in and out of their machines; and only one clerk, besides the bookkeeper, was necessary to keep the men's time and make up the pay-roll. Thus the number of employees classed as non-producers was remarkably small; the manager saw to that, and impressed upon the writer the stern necessity for keeping it down, and reducing it further if possible. The item of "non-productive" expense was so carefully watched and guarded against that the workmens' daily time cards showed that almost the entire time of every man was spent on productive work.

This, however, while apparently representing a very desirable state of affairs, was not indicative of the true conditions, which were something quite different, as will be shown by a more thorough analysis. In reality, only about 50 per cent, or less, of the time was spent in actually producing, the balance being consumed in preparing to do the work, that is, in doing things that should have been done in advance by "non-producers," the rate of pay of most of whom would have been less than that paid to the "producer." To illustrate this point, we will consider that the workman has just finished a job. He then hunts up the foreman to learn what he is to do next; the foreman, after considering, tells him, and the workman finds the job and moves it to his machine. He then goes after the drawing, which may be anywhere in the shop, after which, unless he is perfectly familiar with the job from having done it before, he will again hunt up the foreman for some explanation of what is to be done. The next thing is to set the job in the machine. His clamps are often missing or not suitable, his bolts are not the right length and have no nuts or washers on them, or the threads are in such bad condition that the nuts have to be forced on with a wrench. The writer has seen cases where men have spent as much time looking for a bolt or a clamp with which to hold a job as was required to do the work. After the job has been set the workman looks up his tools, which have to be ground; so he takes his place at the grindstone, which is usually worn out of shape, and waits his turn with the two or three others who are always there.

He has now completed his preparations. The time consumed in making them is charged to the job and considered as productive labor, although in this time neither the man nor the machine have produced anything. All of these preparations, except the actual setting of the job, could have been made by "non-producers" before the workman had finished his preceding job, and the machine could have been producing continuously. The state of affairs here outlined is one which exists, in a greater or less degree, in almost every shop, the management being blinded to it through having its attention taken up by matters of seemingly greater importance, or regarding it as an unfortunate condition of affairs for which it can see no help.

After the writer was thrown out of employment by the failure of the concern referred to, he had the good fortune to become connected with another plant, of about the same size and producing a line of work not differing essentially from that of the first one. This concern had been run for years upon much the same lines as were followed by the firm that failed, but the management had realized in time the necessity for taking some action to avert a similar fate, which had begun to cast its shadow before it; so with this object in view they had started to install the "Taylor System of Works Management."

During the past year the output of this plant has increased more than 100 per cent, with no increase in the pay-roll; and the most interesting thing about it is that, in effecting this result, it was necessary to increase the "non-productive" force from a total of six or eight men to twenty-five men, and to make a corresponding reduction in the number of so-called "producers." In this plant the "Taylor System" provides for having all the preparations made in advance for the workmen; and it is in carrying out the system that the "non-producers" referred to are employed. The nature of their work is outlined in the ensuing paragraphs.

When it is decided to manufacture certain machines or parts, either to fill specific orders for customers or for goods to be carried in stock, a manufacturing order is issued, which passes in turn through the hands of a number of clerks in the "planning department," whose duty it is to plan and arrange for furnishing the tools, materials and appliances to be used in manufacturing the articles called for on the order, and prescribe the methods to be followed in doing the work in the quickest possible time, and in a manner to meet the requirements as to quality.

The first of these "non-producers," called the route clerk, must be a man with practical shop experience, and it is his duty to determine what operations must be performed on each part, and to prepare the route sheets, which indicate these operations and show in what machines they are to be done. He must specify how much of each material is required, specify the number of castings, and must furnish the necessary orders on the storekeeper for the materials. If the articles called for on the manufacturing order consist of a number of parts to be assembled, as in the case of complete machines, the route clerk must plan out the method to be followed in assembling, and so arrange the parts into groups or divisions as to enable the assembling to be done with the least delay; certain groups are thus assembled while the parts for others are still being machined. He must prepare a chart, or working diagram, showing this arrangement of the parts, and giving detailed instructions for the guidance of the assemblers.

The relation of the parts to each other is kept in mind in getting the castings into the shop and in doing the machine work, so as to insure that all the parts of each group shall be delivered to the assemblers as nearly simultaneously as possible. For example, in building a steam engine, if the cylinder, flywheel, and connecting-rod boxes arrived on the assembling floor together, it is obvious that nothing could be done toward erecting the engine; whereas, if the cylinder,

piston, cylinder heads, valve, and steam chest cover arrive together, it is possible to proceed with the work at once.

The manufacturing order next goes to a clerk, who keeps a running balance of all raw and worked materials carried in stock, and subtracts the materials called for from the quantities shown to be available. This clerk is also responsible for issuing orders for replenishing stock, as soon as the quantity available falls to a certain minimum. The foundry clerk orders any castings required that are not regularly carried in stock, specifying the dates on which they must be delivered, and following them up regularly by means of a "tickler."

Instruction cards are next prepared for each operation on each part, giving in detail the method to be followed in setting the job, the tools to be used, the feeds, speeds, and cuts to be used, and the time allowed to do the work. The clerks who make up these instructions must be practical shop men, possessing considerable experience and good judgment. The time allowed for a job is based on "elementary time study," such as Mr. Taylor has described in his papers on works management. Barth's slide rules are used in setting the feeds and speeds at the proper figures. The various orders for performing the operations, for moving the work to another machine after the completion of an operation, for inspecting the work as required, etc., are then written, and the work is begun on the order in the shop.

There are, in the planning department, in addition to the clerks mentioned, the timekeeper, cost clerk, and several messengers, and besides these, the production clerk, the order of work clerk, and the recording clerk. The production clerk sees that orders go through the planning department without delay, and watches the progress of the work through the shop to see that goods are finished and ready for shipment when due. The order of work clerk plans ahead the work to be done by each workman, and arranges the order of work ready to be done by each machine, in accordance with the "Order of Work" or schedule given him by the production clerk; he sees, also, that plenty of work is kept ahead of each workman. The recording clerk enters on the route sheets the progress of the work as it moves through the shop.

In the shop where there was formerly but one foreman there are now several, each of whom has a certain function to look after. The gang boss has charge of the work when the machines are not cutting, and it is his duty to look after the setting up of the work, and the preparations for doing it in accordance with the instruction card. The speed boss has charge of the work while it is being actually machined, and sees that the tools, feeds, speeds, and depth of cuts used, are as specified on the instruction card, and that the workman operates his machine to the best advantage. The inspector is solely concerned with the quality of the work, and it is his duty to see that the work done is up to the required standard of finish and accuracy. The repair boss looks after the repairs and maintenance of the machines, shafting, and belts.

The moving of materials is done by special laborers, and is controlled by the recording clerk in the planning department, nothing being moved except upon a written order issued by him. After a job has been moved to a machine where an operation is to be done on it, the order of work clerk issues the order for doing that operation, and the drawing and the instruction card are delivered to the workman. All tools required to do the work are brought in a "tote box" to the machine by a messenger, tools and appliances of all kinds being kept in the tool room in constant readiness for use. The gang bosses are required to see that these preparations are at all times made for at least three jobs ahead for each workman.

When a workman starts a job, an order is at once sent to the inspector, notifying him to that effect, and requiring him to immediately see that the workman thoroughly understands what is required, and to inspect the first piece finished. This inspection at the start of a job is for the purpose of preventing mistakes being repeated on the entire lot of parts, and is most effective in reducing bad work to a minimum. Upon completion of the entire lot of parts, they are again finally inspected, before being moved to the machine that is to perform the next operation.

With the work thus planned and prepared for in advance, and with the various "functional foremen" not only directing the men, but assisting them to perform a definite task in a definite time, it has been demonstrated that each workman, by actually doing productive work all of the time, can turn out from one to three hundred per cent more work than he is able to do in a shop run as many are, where the planning and preparations are left to be looked after by the one "overworked foreman" and the workman, no matter how competent either of them may be.

In concluding, the writer wishes to call attention to the fact that the "non-producers" in the planning department and in the shop are doing nothing but what had to be done by somebody under the old form of management, with the difference that, under the "Taylor System," each thing is done in a systematic manner by men qualified by training in that particular thing, whereas formerly it was done much less efficiently in the shop, and charged against the job as productive work. The fact that it is being done by a man who should have been producing, but whose machine was standing idle, does not make it productive labor. It does not matter whether the wages for "non-productive" labor are 10 per cent of the total pay-roll or 60 per cent of the total pay-roll, the only sound basis of judgment being a comparison of goods produced per dollar expended. On this basis it has been clearly shown, as in the case of the second plant described, that it is a mistake to fight shy of "non-producers," provided, as before stated, that their efforts are properly directed and utilized. The proportion of "non-producers" required to obtain the best results, depends upon the nature of the product and the quantities handled.

* * *

THE GROWTH OF THE CEMENT INDUSTRY.

The Portland cement industry in this country presents one of the most marvelous instances of growth on record. The use of cement for all forms of construction—for railroad, dock and harbor work, great office buildings, factories, hotels, dwellings, and a thousand and one other things—has occasioned the amazing increase in the output in the United States from 42,000 barrels in 1880, to 35,000,000 barrels in 1905, or over 800 times as much; whereas in pig-iron production the output in 1905 was only about six times that of 1880. This marvelous growth of the cement industry, however, has in no way interfered with the growth of the iron industry. To the contrary, cement has come as an auxiliary to help maintain the vast building activity, preventing an iron and steel famine, which would have upset all building operations throughout the country. As concrete has supplemented iron so has it helped the lumber situation through its use in many forms of construction where timber would otherwise have been essential. The scarcity of timber is growing to an alarming extent. Experts have placed the limit of supply at 35 years. The advent of the cement industry is therefore important in helping to save the American forests from complete destruction. The manufacture of all this cement requires a vast amount of machinery. Many plants have sprung up within the last few years in various parts of this country, whose capacities run up into thousands of barrels daily. Contracts for cement-making machinery calling for an expenditure of hundreds of thousands of dollars are of frequent occurrence to the large cement machinery manufacturers. What is said to constitute the largest individual order ever placed for tube mills for the grinding of cement clinker is one recently placed by the United States Steel Corporation. This order calls for forty-seven tube mills, 5 feet in diameter by 22 feet in length. Twenty of these are to be installed in the plant of the Carnegie Steel Company at Homestead, Pa., and twenty-seven are for an extension to the immense modern cement plant of the Illinois Steel Company at Buffington, Ind. This entire order was awarded to the Power and Mining Machinery Company, Cudahy, Wis.

* * *

The production of gold which has of late commanded so much attention, is still continuing to increase. August returns from the Rand mines in South Africa show that the output is nearly 20 per cent in excess of the output during August last year.

COUNTERBORES WITH INTERCHANGEABLE BODIES AND GUIDES.

ERIK OBERG.

The efforts constantly made by progressive manufacturers to decrease the cost of tools without impairing their efficiency have resulted in the design of a number of holders for cutting tools which permit a cheaper grade of material to be used in the holder proper, while the best quality steel can be used for the cutting tool itself. A further impetus to these efforts has been given by the extensive use of high-speed steel, the price of which is so high as to make its use for many purposes prohibitive, if the whole tool should be manufactured throughout of this material. Many tools which only a few years ago were almost invariably made solid are therefore to-day made up in several parts, the portion which performs the cutting being the only one made out of high grade material. Incidentally another advantage is also gained. Inasmuch as the cutting portion of a tool is the only one which, in general, when worn, has caused the tool to be discarded, it is now possible to retain all the other parts and replace the cutting portion only.

The accompanying cuts show a number of counterbores with interchangeable bodies and guides. In the case of counterbores the interchangeability is even of a greater advantage than in many other tools, inasmuch as here a number of guides can be used with the same body, and *vice versa*, thus making it possible to replace a very large collection of solid counterbores with a single holder and a few bodies and guides.

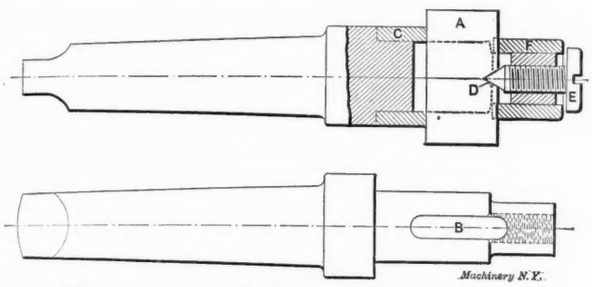


Fig. 1. Counterbore with Interchangeable Blade and Guide.

Fig. 1 shows a counterbore where the body consists simply of a blade *A*, inserted in a slot *B* in the holder. The blade rests upon a hardened tool steel collar *C*, which is driven in place. A slot is milled across the blade in the center at *D*, and a setscrew *E* serves the double purpose of binding the blade against the collar *C* and holding it central. The guide bushing *F* is provided with a small slot fitting over the blade to prevent it from turning, and is kept in place by the head of the screw *E*. There is, however, a slight allowance for play between the guide bushing and the head of the screw, in order to insure that the screw will bind the blade in the slot *D*, and not tighten down upon the bushing before binding the blade. By simply removing the screw the counterbore can be provided with any size blade and guide within certain limits. This class of counterbores is manufactured by the Pratt & Whitney Co.

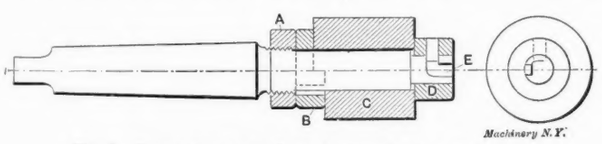


Fig. 2. Counterbore with Interchangeable Body and Guide.

Fig. 2 shows a counterbore of a different type. The collar *B* is keyed to the holder, and is provided with a step as shown in the cut by means of which the counterbore-body *C* is driven. The collar is movable in the longitudinal direction of the holder, being pressed down toward the counterbore by means of the nut *A*. The thrust when binding is taken by the guide bushing *D*, which is provided with a pin sliding in a slot in the guide pin *E*. This slot is milled in the longitudinal direction of the holder about one-half of the length of the guide pin, and is then milled in form of a circular groove about one quarter of a revolution. When the guide bushing with its pin is pushed over the guide pin and given a quarter of a turn, the nut *A* can be screwed down until it holds the body of the counterbore firmly in place. The advantage of this type is that the bushing and body can be very quickly changed and are simple to duplicate.

Fig. 3 shows a counterbore of a somewhat similar type. Here the driving collar *A* is fastened to the holder by a taper pin, and provided with a key freely fitting a slot in the body *B*. The guide *C* is screwed into the holder, and binds the counterbore-body against the driving collar. The guide is provided with a screw slot to facilitate its being screwed in and out. A portion, *D*, on the stem of the guide should be plain and a good fit in a plain hole in the holder, in order to insure that the guide will be concentric with the body of the counterbore. The thread must, of course, in such a case fit very freely.

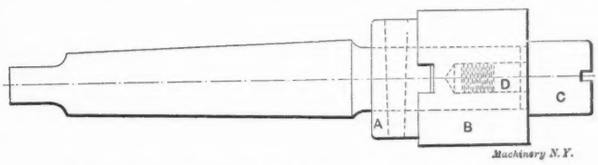


Fig. 3. Counterbore with Interchangeable Body and Guide.

The variations possible are evidently many, but the types represented involve the principles upon which interchangeable body and guide counterbores are designed. The body and the guide should be easy to duplicate, there should be means insuring that they will always remain concentric in relation to one another, and all details, needing fitting when made, should be contained in the holder itself in order to prevent difficulties arising when placing new bodies or guides on old holders.

* * *

There is a large class of persons totally unfamiliar with machine shop operations and who have but the vaguest ideas of the methods and machines employed for reducing forgings and castings to shape required for machine construction. A not uncommon idea of the tyro is that a faced part is done at say one sweep of a broad-face tool, and that cylindrical parts are turned in the same manner. *We*, of course, know that in the beginning the fundamental design of all machine tools was based on the holding of a narrow point tool and feeding it progressively as the work rotated or reciprocated. In this way a small portion of metal is attacked at once and successive furrows are made the same as in plowing a field. The width of the plow furrow is limited to the strength and endurance of the team, and the depth and width of a lathe cut is dependent on the rigidity and power of the machine. In time, as the design of machine tools increased in power and rigidity, the width of the cut was increased; the forming idea became more pronounced and the use of broad-faced tools which would actually sweep at one revolution a complete cylinder of definite length was an established fact. To-day this idea has been carried to an extent which would astonish those who are familiar only with the earlier types of machine tools. For example, a special machine has been built by one well-known concern for facing a certain part in three different places at one operation. Each of these three operations would have required at least twenty minutes if done in an ordinary 24-inch engine lathe of a generation ago. To-day, this special machine, which weighs as much, perhaps, as ten engine lathes, does the three operations in one-twentieth of the time. It literally "hogs" the metal off at say, two or three revolutions, followed with a finishing revolution, and the work is done. It seems hard to conceive of the development of machine tools being carried to a much greater extent than this. Any further improvements would mean the elimination of machining, and perhaps this in time may come when the molder succeeds in producing molds mechanically perfect and which are not destroyed for each casting. This, already done with alloy castings, does not, however, promise much for the more refractory metals like iron, steel and brass. Shrinkage must first be overcome, and this is a large job alone.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1906.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

PATENTABILITY OF INVENTIONS.

With the growth and diversity of manufactures, it becomes more and more difficult to determine the patentability of inventions. At one time it was a fundamental rule that the substitution of material could not constitute an invention, and patents were not granted for improvements of this kind. The same rule holds still, but in a considerably modified form. Some of the most valuable improvements that have been made in certain lines have hinged principally upon substitution of material, this substitution having been effected by a long course of experiments and trials of various materials, etc. Under such circumstances it would seem that the inventor or discoverer should be repaid for his discovery. As an example bearing on this point we may mention the celluloid top of salt shakers. For many years the makers of these utensils sought for some material which could be used for the tops of salt shakers which would not be corroded by the salt or clogged by the deposit of salt around the holes. Nothing in metal was found successful, but upon the substitution of celluloid, made in the form of a cap with screw flange, its success became immediate and millions have been made and sold during the few years it has been on the market. The patent is based on very slender grounds and it seems doubtful that it can be sustained, but the discovery, in a sense, constitutes a valuable invention and the inventor should be as well paid for his discovery as if he had designed a complex mechanism, the like of which had never been known.

* * *

INVENTIONS EXPLOITED BY OTHERS.

It is a curious fact that the origin of many inventions of worth is clouded in obscurity, there being claims and counterclaims by interested parties which make it difficult for the casual investigator to determine the actual inventor. One reason for this is that many inventions have been developed in manufacturing, simply to accomplish a result and without any attempt to manufacture them for the use of others. Thus, it has been no uncommon thing for a man to make a really valuable invention for his own use, and while he might appreciate its value for the purpose designed, his commercial opportunities, perhaps, would not permit him to manufacture it for the market. Lacking enterprise, he also neglects patent protection. Then some one comes along who can see in the machine an opportunity to build up a business in manufacturing it for general use, and the consequence has been that the original inventor often has seen his own idea exploited as that of another and has received absolutely no credit or compensation for the fruit of his genius. But there are two sides to these matters. The inventor was content to make limited use of his idea and cared little enough for the public to put it within its reach. It is not enough that a man shall simply originate an idea in order to be a true public benefactor; he must be responsible for putting it in shape to be used by others, to be so credited. Looking at it from this point of view, the commercial sharp who seizes on to the ideas of others and exploits them to his own benefit is really as much of a practical benefactor as the actual inventor, provided the latter is of the lazy or indifferent type.

* * *

THE ADVANCEMENT THAT COMES WITH WRITING FOR PUBLICATION.

One source of satisfaction to the editors of MACHINERY is the advancement gained by young men who have become contributors to its columns. The subject is of considerable psychological interest as well, for it is somewhat difficult to determine satisfactorily just what is cause and what is effect. We first wrote the title to this article "The Advancement that Comes from Writing for Publication," but it is a question whether it would apply as well as the one given. Take the case of a young machinist of an inventive and resourceful mind, interested in his trade and ambitious for advancement. He reads with avidity what others have done and when it occurs that he, individually, notes methods of doing work which are to him new and novel, it is but natural, if he is of the right turn, to want to tell somebody else about it. He has in the columns of the trade papers an opportunity to speak to a large and select audience, all of whom are interested in about the same subjects that he is, and it is a common instinct to talk to his own kind. Now, the describing of some unusual machine shop job or a new design, etc., is invariably of direct benefit to the young man for a number of reasons:

First, it teaches him to express his ideas concisely and if he has a knack for mechanical drawing, it is exercised in the making of sketches. He thus employs two forms of written language to convey his idea, both of which are constantly used in machine shop work and manufacturing.

Second, the moment he begins to write on a subject he usually discovers that there are a number of things about it which he is not quite sure of, although he thought he understood the subject clearly at the beginning. Consequently he looks into the matter more clearly and studies cause and effect, relation of parts, etc., and gets a clear conception of what he is talking about.

A third benefit that comes from contributing is that the contributor becomes more interested in his favorite trade journal and studies closely what others say and do. His mental vision expands and he usually becomes painfully aware of defects in his education, and this means self-education and mental improvement.

A fourth benefit, and one not to be despised, is the advertising which a young man gets by having his name appear in the columns of a trade journal. Some of his friends may be inclined to sneer at such work, but we say to such that the most progressive men regard work of this kind favorably and there is scarcely any better recommendation to a progressive employer than a few contributions from one's pen.

We do not mean to imply by the above that any young man would necessarily greatly improve his chances of success simply by contributing articles to a trade journal, but what we do wish to impress is that if he is of a certain type he will be moved to write without being urged by ulterior motives, and if so moved it is well to yield to the impulse. Avoid pessimism. Nothing discourages progress so much as the attitude indicated by "What's the use,"—unless it be the selfish concealment of knowledge. A young man afflicted with the pessimistic mind will scarcely ever become a contributor to any trade journal, and it would probably do him little good if he did; but on the other hand, the enthusiastic man, ambitious and desirous of success, hopeful of the future, and willing to learn of the past, will widen his horizon, and gain confidence by expressing his views and opinions, getting, it may be, some hard knocks, but nevertheless gaining strength and wisdom in the process.

AUTOMOBILE FINE SCREW THREADS.

We give publicity to the newly adopted thread standard of the Association of Licensed Automobile Manufacturers, the details of the standard forming the subject matter of the article on page 148 and of the current supplement. It will be noticed that the pitch of the threads of the various screw diameters is considerably finer than that of the Navy, United States or Sellers standard, as it is variably called. For example, the pitch for a ¾-inch screw is 16 threads per inch instead of 10, and about the same proportion holds with all the screws from ¼ inch to 1 inch diameter, inclusive; the number of threads per inch being increased by about 50 per cent on the average.

The needs of the automobile, especially that of the racing type, undoubtedly require a finer pitch screw than the present American screw standard. This feature is one thing that has made for the superiority of the foreign machines, their builders having generally used screws much finer than our standard pitches and thus much less likely to be jarred loose. The Association of Licensed Automobile Manufacturers recognized the condition and adopted the present standard which, in itself, is commendable but somewhat hasty. In giving publicity to it, we do not indorse it, except that we also recognize the need for the finer pitches, not only on automobile construction but certain other machinery as well. We believe it is unfortunate that this move should have been made without a more common indorsement which would have given it a better standing and have paved the way for its general adoption as another standard alongside of the present United States standard. The adoption of a new standard of screws should only have been made after careful consideration and consultation with men whose opinions have weight. How much of this was done we do not know, but it comes as a surprise to most people outside of the automobile business.

It might be said that we had just arrived at the stage of having standard screw threads. The general adoption of United States standard thread brought order out of chaos and was perhaps one of the greatest moves for advancement in machine construction ever made, as it tended toward interchangeability. Now, if the manufacturers of special products, such as automobiles, etc., are to feel free to adopt new standards which seem to them better suited to their peculiar requirements, it will be only a question of a few years when we shall again in a measure be in the confused state as regards screw threads that marked manufacturing before the present era.

The United States standard screw threads are admirably adapted to the needs of heavy work, such as bridges, buildings, cars, locomotives, etc., being easily manufactured and not readily bruised and damaged by rough handling. The needs of the automobile, of course, are quite different. Not only are the parts relatively smaller, but, being made of finer material, much stronger. Better workmanship permits the use of finer screw pitches, and the extreme vibration incident to high speeds undoubtedly requires a system different from that of the United States standard. While some agitation has already been made toward the adoption of a finer system of threads it has not materialized into anything definite. Perhaps this radical departure will bring matters to a focus and result in giving us an authoritative standard of finer pitches adapted to special machinery, either as an indorsement of the one in discussion or of some other—it does not matter particularly so long as it meets the wants and is generally recognized. It is to be hoped that something of this nature will be the result.

* * *

A GROWING OPPORTUNITY.

When the young man is casting about for a profitable and congenial business to which to devote himself for life, if his inclinations lead him toward the realm of engineering, he cannot but feel somewhat disheartened by the state of this profession at the present time. There are scores of engineering schools in the country attended by thousands of students, great numbers of whom are graduated each year. It is truly said that there is a great demand for these graduates on the part of engineering firms in various lines, but this demand is for young men who are willing to work for long hours at small wages for the sake of gaining "practical experience." The upward steps from these positions are difficult and the openings leading to the ascent are few. Besides, the salaries obtained by even the best engineers are not commensurate, so at least it seems to the young man, with the time and study and money which he has expended on his education. Especially is this so when compared with the harvest reaped by the financial managers and the members of the selling organization in great industrial undertakings. The expert in salesmanship, the man who obtains the big contracts and brings in business, is the one who up to this time has been the most valued member of the salaried organization.

It is not safe, however, to consider this as a permanent condition. While this field is an attractive one at present, the increasing growth of the idea of combination and community of interest is bound to lessen competition more and more as time goes on, and competition is the only factor which makes it possible for the selling agent to receive the abnormal rewards which he now enjoys. Considered from a purely abstract standpoint, indeed, this condition does not seem to be a stable one. The salesman's business is an economic waste, so far as the country at large is concerned, in the sense that he does not add to the wealth of the country an amount corresponding to the value he receives for closing his large contracts. He merely diverts business from one channel to another. The consumer is therefore compelled to pay something more than the intrinsic value of his purchase for the privilege of having his order subjected to the fierce rivalry which has hitherto characterized the industrial world.

With the partial decadence, at least, of the importance of the selling end of the business, more and more will appear the necessity for reducing the cost of production to the lowest possible point. Competition in the future will largely be waged in the work shop and factory instead of in the city offices of manufacturing firms. This condition is one that must, in the nature of things, call increasingly for men skilled in the art of production at a minimum cost, who can get the most possible out of men and machines without unduly distressing either. This is the most attractive opening for the intelligent, energetic young man of to-day. The steps that he should take to perfect himself in the art of management cannot be definitely laid down. Each one will have to search them out for himself. A technical education will be no hindrance and should be of great help, not only from the greater knowledge of scientific principles which it gives, but also in the training given in expressing one's ideas in handwriting and in speech and in the broadening influence of contact with numbers of other men with similar aims in life. But a technical training is not absolutely necessary. The works manager has to make large use of the brains of others when it comes to solving engineering problems, and will give up his own time mostly to questions of organization and administration. This can best be learned by actual practice in the art. The steps to be followed are the old-fashioned ones from the ranks of the workmen up through the petty foremanships to the higher positions of responsibility. He must consider, however, unlike the ordinary foreman, that he is studying and striving to master a definite and complicated science—a science of which something has been written and concerning which some experimental work has been done, but which is in the main a region whose prominences are unmapped and whose routes of travel are undetermined and unmarked.

The typical manager of the past, like the old-fashioned engineer, attained his eminence through unusual and fortuitous natural endowment. The efficient manager of the future, like the engineer of the present, will depend for his success on accurate analysis of the conditions with which he is confronted, and carefully considered and executed plans for accomplishing the results he desires. This is the field which to-day presents the most inviting opportunities in the mechanical world. As to how it shall be entered, each one must determine for himself. There are few places where one can serve a definite apprenticeship in the art, and no college has yet added the study of the science to its curriculum.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Mechanical World states that a new alloy for turbine blades, containing 80 per cent copper and 20 per cent nickel, has been found to be the most satisfactory metal for the purpose as yet discovered. Of the alloys formerly used those containing zinc are said to be extremely unreliable at high temperatures, particularly when used with superheated steam.

A new German process of case hardening is claimed to give results superior to any hitherto obtained. It is said that a piece weighing 400 pounds can be hardened 0.040 inch deep, and so hard that no steel will cut it, though it may be welded. The work to be hardened is heated in bone dust powder to which is added ¾ pound of yellow prussiate, ½ pound of cyanide of potassium, and one pound of phosphorus. It is heated to a very high temperature in a closed box.

Lead wool, made in Germany, is used principally for caulking pipes, the joint being filled cold against a backing of hemp or tarred yarn. It is considered a good substitute for melted lead in making joints for hub and spigot cast iron gas mains. This "blei-wolle" is lead which has been shredded to about the size of heavy thread, collected into bundles of convenient length and of a size in proportion to the joint to be filled, twisted somewhat.—*Mining Reporter.*

Pure copper cannot be cast in sand without considerable difficulty; in fact, some deoxidizer is always used. For common copper castings from 2 to 5 per cent zinc is generally added to get sound castings; but for electrical work this is useless. The only way to get good electrical castings is to melt pure electrolytic copper in a plumbago crucible under a thick layer of charcoal. When thoroughly melted add 2 per cent silicon copper and stir it in with a stick and cast as soon as ready. Practical experience alone will show the correct temperature for casting copper in sand molds, and the proper temperature of the sand. It must not be cast boiling, but a fairly high temperature is necessary.—*Metal Industry.*

The *Maschinen- and Metallindustrie-Zeitung* has made calculations to the effect that a grown person receives through his food an amount of heat equivalent to about 12,000 or 14,000 B. T. U. a day. Only 1,200 B. T. U. are during an eight-hour day transformed into work, and the exertion of a man under these circumstances is equivalent to 0.08 H. P. Granting these figures to be correct, it is further stated that the efficiency of the steam-engine, the cost of its running being compared with the wages paid for labor, is 150 times greater than that of human exertion. No wonder then that we try to replace the brute force of man with motors of all descriptions wherever possible, and rather use the mental powers of man which no machine has as yet been able to replace.

A German manufacturer, Mr. Julius Pintsch, of Berlin, has made a number of experiments in order to ascertain the comparative durability of various metals when exposed to the heated exhaust gases from internal combustion engines. The experiments indicate that bronze and copper are least adapted to endure exposure; nickel and brass are possessed of more enduring qualities, while machine steel, nickel steel and cast iron show little depreciation from exposure. Cast iron stood the test far better when not finished, but even finished cast iron proved to be well suited for exposure of this character. The exhaust gases in the experiments referred to had a temperature of 700 degrees F. So high a temperature, of course, is not necessary for the exhaust gases if the machine is provided with a proper provision for cooling off the cylinder walls.

United States Consul Griffith, of Liverpool, has sent to Washington a brief note concerning an automatic train stop which has been in use at one or more places on the North Staffordshire Railway for two years. The apparatus, devised by Mr. T. E. R. Phillips, of Liverpool, consists of a "tripper" fixed on the sleepers between the rails which, when a signal is in the stop position, actuates a visual and an audible signal in the locomotive cab. The apparatus is also designed to apply the brakes. A great number of similar devices have been patented, but have not proved successful. One fault common to a large number is that the inventors have not considered the inertia of parts suddenly moved from a state of rest to a velocity of, say, 88 feet per second, and this is what happens to a "tripper" when struck by a train running a mile a minute.

The uses of bismuth are fairly numerous, and recently the German and French governments adopted this metal in place of lead for the cores of rifle bullets. The alloys of bismuth with lead and tin are well known for their easy fusibility and their property of expanding on solidification. Their fusibility can be increased by adding cadmium. Usually alloys contain from 20 to 50 per cent bismuth, 25 to 50 per cent lead, 4 to 20 per cent tin, and occasionally a little cadmium. There has been further research work on copper-bismuth alloys to determine their physical characteristics and to decide what percentage of each metal will make the best eutectic mixture. The structure of copper alloys containing 98 per cent or more bismuth resembles pure bismuth. Alloys generally are valued by the market conditions of their constituent metals.—*Mining Reporter.*

It appears that the Kjellin electric furnace for the production of steel has developed beyond the stage of mere experimenting, as this method is now reported to be far enough developed for utilization on a large scale in Sweden. The immense water power at Trollhattan will be utilized for this purpose and the Swedish government, which controls this water power, is expected to give the necessary permits to the exploiting company. The promoters expect to build a steel mill for producing at least 500,000 tons of steel annually, and at least one mill of the same size is expected to be erected in another part of the country. The extensive iron ore deposits in the northern part of the country will furnish all the raw material necessary. The Krupp Works are reported to have acquired the Kjellin patents for Germany and will erect large mills for their utilization.

William Marriott, an English civil engineer, makes a very interesting statement in the London *Times Supplement* regarding what has been called the "growth of iron." He asserts that during an experience of more than thirty years he has become convinced that iron increases in volume through continued heating and cooling. Mr. Marriott writes: "Rails that have fitted swing bridges with plenty of clearance have had to be shortened repeatedly year after year, and only recently I have known an instance of a swing bridge which had been open for half an hour that could not be put back until some of the ironwork had been reduced. The bridge had been built for some thirteen years and had been opened and closed during that time many hundreds of times. There is little doubt in my mind that iron heated and cooled alternately does permanently lengthen."

On September 30 the first run with a heavy electric train was made on the New York Central R.R. from Highbridge to the Grand Central Station. About November 10 it is expected to have electric engines running regularly between the Grand Central Station and Highbridge. The smoke nuisance in the tunnel will, however, not be fully eliminated for some months, as the electrification of the New York, New Haven & Hartford R.R. is not yet far enough advanced to permit steam to be abandoned on this line. Enough has already been accomplished, however, to remedy the disagreeable features of the entrance to New York by way of the tunnel, and to indicate that marked improvement in suburban traffic accommodations

will follow the completion of the undertaking. The first trip through the tunnel was made with open windows without annoyance, except from the small amount of gas left in the tunnel from preceding trains.

In establishments expecting to produce a uniformity in their output, estimating the heat of a piece of steel by the color is no more considered safe. No two men will agree as to the color of a piece in any one fire or bath. The same temperature will be differently estimated in different parts of the shop or at different times of the year or day, according to the light, and no two kinds of steel will show the same color for the same temperature. For these reasons the eye cannot be depended upon. There are, however, means for measuring temperatures used by manufacturers of fine porcelain which undoubtedly would be valuable to steel workers to enable them to ascertain with certainty the temperature in a furnace. The method consists in the use of porcelain or clay cones of various melting or softening points. Sixty different grades exist, each stamped with a number corresponding to the different temperatures at which the cones will collapse. The range of these temperatures is between 1,094 to 3,522 degrees F.—*Scientific American.*

According to the *English Mechanic and World of Science*, Messrs. Siemens and Halske, of Berlin, Germany, have recently patented an alloy which is especially suited for use as a bearing metal. They state that it is superior to the usual white metal in that it is very easily worked and particularly easily turned, that it fills up the mold completely when cast, that it possesses relatively great hardness, and, what is most important, that it has an extremely small coefficient of friction. The alloy is made by melting together approximately equal parts of cadmium and zinc, with an addition of a small proportion of antimony. The alloy can, for example, consist of 45-50 parts of cadmium, 45-50 parts of zinc, and up to 10 parts of antimony. The antimony added should not exceed 10 per cent, as otherwise the metal is too brittle. A very suitable proportion of antimony is 5 per cent. If the proportion of cadmium and zinc is considerably varied, the coefficient of friction increases, and the other good properties of the alloy are essentially prejudiced.

As a result of tests made on an experimental steel coach, the Pennsylvania Railroad has decided that all its future passenger equipment shall be made of steel. The necessity for providing non-collapsible and absolutely fireproof passenger cars for the Hudson River tunnel has led to this decision. The experimental car, it is stated, could stand any load or any collision. Its hidden frame is like a cantilever bridge, suspended on the trucks as piers, insuring safety against telescoping. The car weighs 103,550 pounds, against 84,500 pounds for the standard wooden coach; but it is found that the added weight very greatly reduces the vibration and adds to the comfort of the passengers. The decision now arrived at means that there must be rapidly constructed 1,000 fireproof cars, to be ready when the tunnel is completed. The Pullman Co. has also decided to build a steel sleeper which weighs some 25 per cent more than the standard wooden coach. The frame is of cantilever construction similar to a bridge and the flooring of the car and platform is of imitation stone spread on steel plates. Doors are of steel plate filled with cork to prevent noise, and the roof is of composite boards covered with copper sheathing, the inside lining being of composite boards covered with fireproof paint.

An explosive, which cost only one-tenth as much as dynamite, was experimented with at the Simplon tunnel, but had to be abandoned because of a peculiar disadvantage. As described by M. Jacquier, in the *Annales des Ponts et Chaussées*, it was made by soaking meal or powdered charcoal in liquid air or liquid oxygen, the powdered carbon being first packed into a case made of stout paper and covered with an asbestos wad, through which passed a paper tube to the bottom of the cartridge. Just before firing, the liquid air was poured in, and the firing was done by means of a fulminate cap as usual. Not over ten minutes should be allowed to elapse after filling before firing the cartridge, as the liquid air is gradually evaporating, and at the end of half an hour has completely disappeared. From this results one of the great advantages of the explosive, namely, that if it should miss fire, it is only necessary to wait awhile and there will be no danger whatever to the men. The dynamite used in the construction of this tunnel cost $27.50 per lineal yard of single tunnel; therefore this new explosive would have effected a great saving if it had been possible to use it. The reason why it could not be used was that it produced such great quantities of carbon monoxide (CO), that the atmosphere in the tunnel became very injurious to the workmen.—*English Mechanic and World of Science.*

ALCOHOL FROM CORNCOBS.

The Department of Agriculture is developing a new industry in the production of alcohol from corncobs, which, the department says, promises to be of much commercial value. Investigations are being made at Hoopeston, Ill., and have proved that the large quantities of corncobs which every year go to waste can be made to produce alcohol in sufficient quantities to justify the erection of a distilling plant in connection with a corn cannery. So far the department has succeeded by simple methods of fermentation in getting a yield of 11 gallons of alcohol from a ton of green cobs, and by similar methods in getting 6 gallons of alcohol from a ton of green cornstalks. A department official says that these tests show that there are 240 pounds of fermentable substance in a ton of green field cornstalks, which will yield about half of its weight in absolute alcohol. In round numbers a ton of stalks will produce 100 pounds of alcohol or 200 pounds of proof spirits. As a gallon of alcohol weighs nearly 7 pounds, there should be 15 gallons of alcohol in a ton of stalks. The addition of the corn on the cob adds further to the possibilities of alcohol obtainable from a ton of cobs, and will have its influence in bringing the quantity to a greater figure.—*Horseless Age.*

TURBO-BLOWERS.

In a paper recently presented at a meeting of the British Association for the Advancement of Science by Gerald Stoney, on the subject of "Recent Advances in Steam Turbines—Land and Marine," the author described the development of the steam turbine for driving rotary air compressors of the turbine type, which are now being used largely for blowing blast furnaces. The advantages gained are light weight, small foundation, small consumption of oil and above all, high economy of steam over the reciprocating types of blowing engines. The outfits described are generally for about 20,000 cubic feet of free air per minute, and a pressure of ten to fifteen pounds per square inch. A slightly different type is made for about 30,000 cubic feet per minute, at about one pound per square inch pressure. These blowing equipments are being used in several large iron works for dealing with the waste gases from furnaces and for driving these gases through the recovering plant, etc., an important feature being that they do not clog with tar and other matters. Since it is nearly impossible to use economically low-pressure steam at about atmospheric pressure in a reciprocating engine, the exhaust steam turbine becomes an important factor in those cases where there are non-condensing engines and other sources of exhaust steam.

WIND MOTOR FOR ELECTRIC LIGHT AND POWER STATION.

While wind power has never been very extensively used in this country (excepting in the prairie regions of the West), some European countries (and among them Holland in particular) have made use of this cheap power to a very great extent. The wind motor, however, has been used only for such purposes where a certain and constant amount of power was not a necessary condition, and where the variations in speed did not in any way interfere with the working of the driven machinery. In some cases there have been attempts made to provide the wind motors with devices which would

permit the driven machines to run at constant speeds no matter what be the speed of the wind motor itself. But even such devices could, of course, not eliminate the uncertainty of the amount of power. Of so much greater interest is therefore the report that a wind motor has been in successful operation for two years, furnishing the required power for an electric light and power plant in the small town Arkow, in Denmark. When using the wind motor for such a purpose some other kind of a motor must, of course, be kept in preparation for emergency cases. Even so, however, is the proposition of using the wind power a particularly economical one, as has been proven by this electric plant, which pays a net profit on the investment of 12.5 per cent. Regarding the efficiency of this particular motor the *Zeitschrift des Osterreichischen Ingenieur und Architekten-Vereines* states that with a wind velocity of 20 feet per second each 60 square feet of blade surface will generate 1 H. P., out of which 86 per cent will reach the electric generators.

HOLDING POWER OF RAILROAD SPIKES.

The Forest Service of the United States Department of Agriculture has completed a series of tests to determine the holding power of different forms of railroad spikes. The tests were made on ordinary commercial ties of loblolly pine, oak, chestnut, and other woods. The spikes used were of four kinds: common driven spikes, a driven spike which has about the same form as the common spike with a lengthwise channel on the side away from the rail; screw spikes of the American type; and screw spikes similar to those in use on European railroads, and differing from the American spike mainly in the manner of finishing the thread under the head.

The common and the channeled spikes were driven into the ties in the usual manner to the depth of five inches. A hole of the same diameter as the spike at the base of the thread was bored for the screw spikes, which were then screwed down to the same depth as the driven spikes. The ties were then placed in the testing machine and the force required to pull each spike was recorded.

The average force required to pull common spikes varies from 7,000 pounds in white oak, to 3,600 pounds in loblolly pine, and 3,000 pounds in chestnut. The holding power of the channeled spike is somewhat greater. For example, about 11 per cent more force, or 4,000 pounds is required to pull it from the loblolly pine tie. The two forms of screw spikes have about the same holding power, ranging from 13,000 pounds in white oak, to 9,400 pounds in chestnut, and 7,700 pounds in loblolly pine.

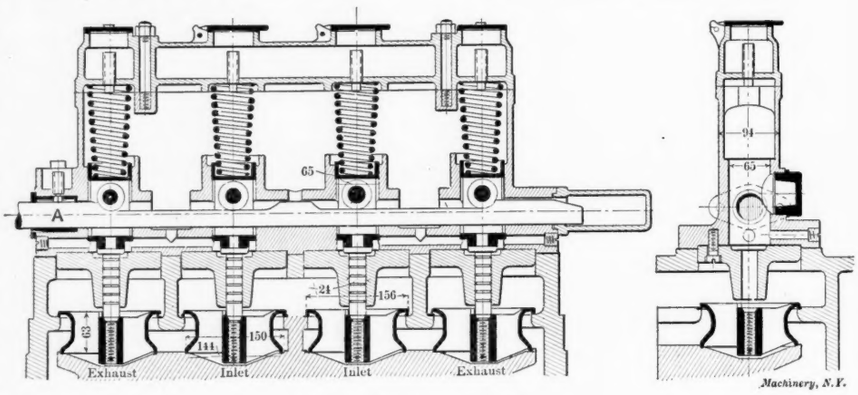
There is a marked difference between the behavior of driven and screwed spikes in knots and in clear wood. Knots are brittle and lack elasticity, so driven spikes do not hold as well in them as in clear wood. In the case of common spikes in loblolly pine the decrease of holding power in knots is as great as 25 per cent. On the other hand, screw spikes tend to pull out the whole knot which they penetrate. This increases the resistance so much that in lobololly pine the increase of holding power of screw spikes in knots is about 35 per cent over that for clear wood.

USE OF GRAPHITE TO PREVENT CREAKING.

Graphite has other lubricating uses besides its application to running journals. It is used with good results to overcome the fiendish propensity of car windows to stick, and according to *Graphite* it has been used with marked success to overcome the creaking and cracking noises made by poorly built cars when rounding curves and running over uneven track. An instance is given of a private car which had given much trouble from noise of this character. It was entirely rebuilt and all joints and seams were thoroughly covered with graphite before being put together. The result was that the creaking was entirely eliminated. Of course part of this might have been due to the improved condition of support and construction, but there is no doubt that graphite in places like this would allow the parts to move upon each other with greatly lessened friction and this means less noise and distress.

LOCOMOTIVES WITH POPPET VALVES.

The use of superheated steam in locomotives has not made any great headway owing to the fact that it does not work well with slide or piston valves. To overcome this difficulty, the Hanover Locomotive Works, in Hanover, Germany, about a year ago reconstructed a small engine that came into the works for repairs, equipping it with poppet valves of the Lentz type. The design of these valves is shown in the two sectional elevations taken at right angles to each other in the cut. The two center valves are for the inlet, and the outside ones for the exhaust. They are actuated by the end movement of rod *A*, which is made with elevations on one side to move the valves at the proper times. The valves are held closed by means of springs which do not have to be very stiff, as the valves only weigh about 8 pounds each. Tests made of this engine in comparison with another one of the same size equipped with slide valves showed a decided saving in water and fuel, 30 per cent and 19 per cent respectively, while the durability of the valves was well demonstrated by the fact that after running 11,000 miles they were in perfect running order. The operation of the poppet valves on this trial locomotive was so satisfactory that the Hanover works have constructed a larger engine of the same type.



Poppet Valves for Locomotives.

CAST-IRON WHEELS.

The Master Car Builders' Association has adopted by letter ballot the two recommendations of the committee on cast-iron wheels increasing the thickness of the flange one-eighth of an inch and changing the coning of the tread from 1 in 25 to 1 in 20. Increasing the thickness of the flange is not a new suggestion; it was first made several years ago and then dropped because it was considered impossible to run a thicker flange through the frogs and guard rails. The American Railway Association, after an investigation of the limiting conditions of modern track, has approved the change, and there are now no objections on the grounds of safety. How much strength and durability this ⅛ inch of metal will add to cast-iron wheels is yet to be determined by laboratory tests and actual service.

The committee report, in recommending the change in the taper of the tread from 1 in 25 to 1 in 20, says: "The reason for asking for the change in the taper is due to experiments that have recently been made which indicate less flange wear and a longer life to the wheel on this account."

The comments made on taper of wheel treads by Mr. M. N. Forney in his paper on the Relation of the Wheel to the Rail, presented to the Master Car Builders' Association in 1884, are pertinent:

"The relative advantages of coned and cylindrical treads of wheels have been in dispute ever since railroads were first built. Whatever advantage may accrue from the use of coned wheels is soon lost because the cone of the treads is rapidly worn away, and the wheels become either cylindrical in form or approximate thereto."

It may be, however, that the coning has more influence than

is usually accredited to it. In the topical discussion on the allowable variation in circumferences in mating wheels, it was said that if one wheel is made 1-32 inch larger in diameter than its mate, such a wheel will not run sharp. It is probable that a pair of new wheels will act on the rails like a barrel rolling on skids; that is, so adjust themselves that they will roll on points of equal diameter, and it is evident that this will be the more easily accomplished the sharper the cone of the tread. Hence, if they are brought to bear, when new, on points of equal diameter, they have the probable advantage of being liable to wear evenly and thus be of the same diameter when they are worn to the cylindrical tread. The change suggested by the committee is a reasonable one and may do something towards the elimination of sharp flanges, but the change is so small that complete relief cannot be hoped for.—*Railroad Gazette.*

REMOVING OIL FROM EXHAUST STEAM.

Abstract from a paper read by Albert A. Cary before the American Society of Refrigerating Engineers.

Separation of oil from condensed steam has been a problem of great moment, and many methods and devices have been used to effect its removal, all of which may be classified in six divisions in the first of which baffle plates or screens are used, the exhaust steam being thrown against these surfaces and allowed to pass, while moisture and free oil cling to the plates and are separated. In the second method, the steam delivered by the engine is sent through filters, generally composed of coke or some other loose material, while in the third process the steam is exhausted from the engine through a series of pipes having their lower ends immersed in water, which is supposed to wash out the oil and allow the steam to pass to its place of exhaust. A fourth method makes provision for the steam exhausted from the engines to be projected upon the surface of a large tank of water, where the oil attaches itself to the water surface, while the steam is allowed to pass on to its point of exhaust. The fifth method allows the steam with its charge of oil to be condensed and then carried to a skimming tank, where the oil is supposed to rise to the surface of the water and float off, while the cleared water is drawn from a point some distance below the surface. In the last of all the methods purification is effected by passing the oil-charged condensed steam through various filtering mediums, such as blankets, sponges, straws, excelsior, etc., and depending upon their oil-retaining properties to clear the water of its contained oil.

Recently a new process has been devised which provides for the introduction into the water of a small percentage of a special material, the nature of which is at present a secret, which has a great affinity for oil. As this material is stirred throughout the condensed steam, it takes up the oil in the same way that blotting paper takes up ink. Tests thus far made show that the separation of oil from water by this process is absolute and complete.

Oil is present in exhaust steam in three different forms: first, as a vapor; second, in finely subdivided particles of oil; third, in the form of a coating around the small particles of condensed water existing in exhaust steam. In all of the processes of oil separation, excepting the last described, it will be seen that it may be possible to ensnare and filter out the finely divided particles of oil floating in the steam and also the minute particles of water with their oil coating, but it is difficult to take care of the vaporous portion of the oil, which has proved most troublesome to the users of such devices. When oily steam is condensed, oil is found existing in the resulting water as a free oil, little clots of which, either separately or combined, float to the surface of the water. Conceiving the idea that a substance might be obtained which would have a greater attractive force for the oil than the surface of water, the inventor of the new process discovered the material already mentioned. So effective is this material that the quantity used for oil extraction is but one-twentieth of 1 per cent of the weight of the water itself, and after being introduced into the water, it has proved so light and feathery that a little stirring causes it to diffuse itself throughout the volume of oily water. This extreme lightness and ability to diffuse itself throughout the water soon causes the material to get in contact with all of the oil, which seems to leave the water suddenly and attach itself to the material. Thus, in a few minutes the water becomes cleared and all that is needed to produce a liquid as clear as crystal is a rapid filtration of the oil and water with its contained oil-absorbing material. Samples of water obtained from various power stations and subjected to this treatment have shown no trace of oil in the filtrate when analyzed by the most delicate chemical means. The material has such a capacity for oil that it can be used several times before a new charge is required, and, further, the cost of the original material is small.—*The Engineer.*

THE ROTARY GAS ENGINE.

W. L. Chambers, in The Engineer, October, 1906.

Much on the possibilities of the gas turbine is printed in engineering magazines of the day, and it must be admitted that there are certain advantages to be gained in the use of that form of motor. At the same time there are certain obstacles in the way of its successful operation which make the turbine impracticable, at least in almost every form yet devised. Chief of these difficulties is the inability to keep the temperature of the blades below the point of oxidation, which renders them brittle and useless. Several ways of overcoming this difficulty have been suggested, but no one so far seems to have been able to surmount the mechanical obstacles presented. A little study of the faults of the common reciprocating gas engine has led the writer to the belief that there is a greater chance of success in the field of the rotary gas engine of the explosion type than in the turbine. The rotary has no greater cooling problem than the reciprocating engine, and it is quite possible to get one, two, or even three explosions per revolution, instead of one every alternate revolution, or, at best, one each revolution, as in the ordinary four-cycle and two-cycle types.

If, in the reciprocating engine, two impulses are obtained per revolution, it must be in the two-cycle, double-acting type with pump and one cylinder or two-cylinder, two-cycle, single-acting crosshead type or four-cylinder, four-cycle type. Any of these have a great multiplicity of parts and the first two are open to the serious fault of all two-cycle engines, viz., that of imperfect scavenging, which allows a large amount of burned gases, varying with the back pressure of the exhaust, to be mixed with the incoming charge. This mixture of the gases is very liable to cause back firing. In the four-cycle type nearly a fixed amount of burned gas is left in the ports, explosion chamber, etc., which as in the two-cycle is mixed with the new charge. This amounts to from one-sixteenth to one-quarter of the entire volume of the cylinder, varying with the compression. If the compression is high, the amount is less in proportion, but increases rapidly as the compression is lowered. No such trouble would be encountered in the rotary, as it could be made to scavenge almost perfectly and obtain the full benefit of a clean charge.

Even more than the turbine the rotary would reduce the size per unit of power over the common type, due to the fact that the rotor of the turbine would of necessity have to be made large to keep down the angular velocity, while the rotary could be made as compact as possible. The greatest advantage, however, of the rotary over the reciprocating engine would be, that the power of each impulse is applied constantly on the tangent; hence, the turning moment would be always equal to the pressure at any point, while in the reciprocating type the turning moment varies for small close-connected engines approximately as given in the accompanying table:

	Pressure.
Beginning of stroke	0.00
1/8 of stroke	0.444
1/4 of stroke	0.668
3/8 of stroke	0.84
1/2 of stroke	1.00
5/8 of stroke	0.75
3/4 of stroke	0.60
7/8 of stroke	0.44
Full stroke	0.00

This variation is due to the imperfection of the crank and connecting rod as a means of power transmission. The above factors coupled with the constantly varying pressure, which

falls rapidly after the beginning of the stroke, make the average turning moment only about 0.45 of the average pressure on the piston. The rest of the pressure, about 0.55, is simply lost in strains and friction.

Another advantage of the rotary over the common type is its compactness, the rotary having something like 8 to 1 the advantage in cubical space occupied, and about 3 to 1 in floor space.

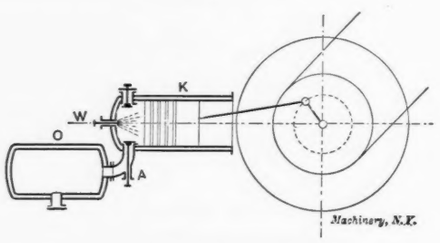
Owing to the comparatively small cylinder volumes to piston areas in some forms of rotaries, the volume of gas consumed would be, theoretically, nearly 40 per cent less than in its reciprocating competitor. In practice it would in all probability not more than equal the common types, owing to the difficulty of keeping rotary cylinders tight enough to prevent leakage without undue friction.

There is one thing in the rotary, however, that promises to be a little difficult, and this is its lubrication. But this is far from an impossible problem, although a somewhat complicated one owing to the number and location of places that require oil.

NITRIC ACID AS A GAS ENGINE BY-PRODUCT.

Cassier's Magazine, August, 1906.

One of the great chemical and economic problems is the discovery of a commercially profitable method of fixing the inert gas, nitrogen. This element is a valuable one, being used in various combinations in the arts, and having an especially broad field of usefulness as a plant food. The problem of obtaining it, however, in a form suitable for use is a very difficult one. Mr. F. E. Junge contributes to *Cassier's Magazine* a description of a process developed in Germany in which the gas engine is used as a medium for performing this highly valuable but difficult operation.



Nitric Acid as a Gas Engine By-product.

After discussing the various methods for the fixation of nitrogen it can be shown that the most available compound for this purpose is nitric oxide, which is composed of equal quantities of nitrogen and oxygen. This combination takes place at high temperature. After the gas is cooled to a low temperature it will absorb another atom of oxygen from the surrounding air, forming nitric dioxide and this will in turn dissolve in warm water to form nitric acid according to the formula:

$$2\,NO_2 + O + H_2O = 2\,HNO_3.$$

This last action is effected by spraying the water into the gaseous mixture in finely divided form. We thus, in this process, have a very simple means of making HNO_3 by the exclusive employment of water and air, both of which can be had practically without cost, and in unlimited quantities, if it only be possible to find a cheap and realiable method of making NO.

The two constituents of this substance, nitrogen and oxygen, are both present in the gas engine cylinder as constituents of the air drawn in with the charge. When analyzing the exhaust gases of an ordinary gas engine it will be noted that if the engine is running very hot the exhaust shows a marked smell of nitric oxides, and it is obvious that under specially-prepared conditions this phenomenon may be made to appear regularly. At the highest temperatures, which are almost coincident with those of maximum pressure, part of the atmospheric nitrogen will combine with the surplus oxygen to form NO. To avoid decomposition of this combination the mixture must be guarded against gradually cooling down by adiabatic or other expansion—in other words, the gases must be quenched by the sudden injection of cold water. The quantity and distribution of this water injection will, therefore, determine the drop of temperature and pressure of the gases in the compressor cylinder, whence they are allowed to escape through a valve into an exhaust vessel, where they are mixed with water and air to produce first NO_2 and then HNO_3, according to the formula given above. The accompanying cut shows diagrammatically the apparatus employed, *K* being the cylinder of the gas engine, *W* the water inlet valve for quickly cooling the nitric oxide, while *A* is the exhaust valve leading into the chamber *O* where the nitric acid is formed.

The questions that naturally arise when studying this process are, first, the time or duration of high temperatures sufficient to produce NO in such quantities as will make the process an economical one; and second, whether the energy absorbed as negative work for carrying out the mechanical process of compression and the establishment of high pressures is low enough to be a negligible quantity in the commercial application of the invention. Herr Häusser, who described the process before a branch of the Society of German Engineers at Kaiserslautern, produced evidence tending to show that neither of these were of sufficient importance to make the process an unprofitable one. An attractive feature of the invention and one that is likely to hasten its industrial exploitation lies in the fact that the principle underlying it is extremely simple and can be carried out by almost any owner of a gas engine without increasing the initial cost, operating expenses, floor space, or complexity of the plant in any but a very small degree. The amount of power produced from a given engine with a given amount of fuel is of course reduced, but it is claimed that the value of the nitric acid generated exceeds the cost of the power lost to such an extent as to make it seem that the process stands on a sound commercial basis, as far as Continental conditions, at least, are concerned.

THE BEGINNING OF MECHANICAL VENTILATION AND HEATING.

Compiled in part from an article by R. T. Crane in the Valve World.

The history of heating and ventilating engineering in this country commences with Joseph Nason, who, upon his return from England in the latter part of 1842, began the introduction into this country of the Perkins system of hot-water heating, with which Mr. Nason was thoroughly familiar, having been for some years, while in England, in the employ of Mr. Perkins. In 1846 a radical departure in the method of heating—in this country at least—was made by the warming of the Boston custom house by means of mechanical propulsion of air. A large coil of ¾-inch pipe was massed in the basement, and from it to the several registers were run ducts of sufficient capacity to carry the warmed air. This plan of warming, while not new in France, was entirely novel in this country, and was the beginning of all subsequent systems in which fans were employed for distributing air. The fact that this plan of warming had already been employed in France does not detract from the credit due to Mr. Nason, as there is no evidence that while abroad he went to France, and it is highly probable that he was not familiar with the progress that had been made in that country. In 1855, in which year extensive alterations of and additions to the United States Capitol at Washington were in progress, Mr. Nason, at the request of General Meigs, then in charge there, went to Washington and planned a system of ventilating and heating for the Capitol. This was the first really scientific and complete job of the kind done in this country. Mr. Nason, as this job at the Capitol shows, had a thorough knowledge of the business, as it was then well known, and was at the time unquestionably the best informed and most experienced person on heating and ventilating in the United States.

The apparatus installed under Mr. Nason's direction consisted primarily of a heating surface of wrought-iron pipe, over which air was forced by means of two specially designed centrifugal fans, and conducted through ducts to the rooms to be heated and ventilated. This plan of having a large amount of heating surface located in one place and the air blown through it, the heated air being then conducted to such

places as it was needed, was for some years the favorite mode of heating. Some years after, a job of this kind was put in the new post office at Washington. It was also placed in several insane asylums.

In the late fifties B. F. Sturtevant began his work in Boston, which eventually led to his building up the largest blower business in the world. In the course of ten years he developed the blower and its uses to such an extent that it became a recognized factor in satisfactory ventilation. He replaced the United States Capitol fans with others of more modern design, and about 1870 entered the market with a unit combination of fan and steam heater. From the somewhat crude design of that day has been evolved the present type of fan blower heating apparatus to be found in every important public building and in thousands of industrial plants throughout the world.

BRIQUETTING TESTS OF THE FUEL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY.

The United States Geological Survey has conducted a number of tests on the briquetting of fuel at its fuel-testing plant, St. Louis. The results of these tests are summarized in a preliminary report recently issued. In the making of coal briquettes, the binding work is best performed when the particles of coal are coated and the void spaces are filled with binding material. This is best accomplished when the temperature of the mixture before compression is raised sufficiently to liquefy or vaporize the binder. The relation between the coal and the binder seems to be physical rather than chemical. The more important requisites of a suitable binding material for briquettes are as follows:

1. It must be inexpensive because of the small difference in the United States between the prices of slack or fine coal and those of lump coal. 2. It should be capable of abundant production in different parts of the country to avoid the necessity of long transportation. 3. It should be of such character as to make it easily handled and applicable at working temperatures. If used in solid condition, as in the case of pitch, the melting point should not be lower than the temperature of hot summer days nor ordinarily above that of live steam. 4. It should hold the briquette together strongly, not only during ordinary handling and transportation, but also during protracted exposure to weather and while burning. 5. The binder should not add appreciably to the ash of the coal, nor increase the clinker formation in the ash. It should not give off fumes, nor seriously increase the smoke in burning the briquettes. 6. The binding material should increase, or certainly should not decrease, the heating quality of the coal which is used in the manufacture of briquettes.

The condition which more than any other has prevented the development of the briquetting industry in this country is the low price of bituminous coal and especially the small difference between the price of the lump coal and that of the slack, or fine coal.

The high cost of the pitch which is generally used as a binding material is also one of the barriers existing in the way of the development of this industry. One of the purposes of the present investigation is to discover, if possible, some cheaper binding material, and the outlook in that direction is encouraging. The cost of manufacturing briquettes in France, Germany, Belgium, and England, including all necessary items except that of the coal and binding material, is estimated to range from 25 to 50 cents per ton, varying with the local conditions. Where pitch is used as a binder, as is almost universally the case in each of these countries, its cost for a ton of briquettes may be said to range from 50 to 80 cents. How far this cost may be reduced by the use on a commercial scale of cheaper binders remains to be seen. The most favorable outlook for the development of this industry in the United States is in connection with the use of briquettes in locomotives and in domestic furnaces and stoves. It can hardly be expected that, at anything approximating existing prices, briquettes can be manufactured for successful use in the ordinary power-plant furnaces of the country.

The briquettes experimented with weigh about 3½ pounds, and were made of such a size as would most nearly fulfill the requirements of stationary and locomotive boiler practice.

In the laboratory investigations, various substances were tested as binding materials in the manufacture of briquettes, both as to the possibility of their being used with the different varieties of bituminous coal and as to the percentage of each binder yielding the best results with each coal. These investigations related not only to the nature and the amount of the binder necessary for making satisfactory briquettes with each of the several coals tested, but also to the extent to which the binding quality of certain of these materials might be improved by the admixture of another binding material or another variety of coal.

The binders may be divided into two general classes—inorganic and organic. The former comprised clay, lime, magnesia, magnesia cement (magnesium oxide and magnesium chloride), plaster of Paris, Portland cement, natural cement, slag cement, and water glass. The organic binders consisted of wood products, sugar factory residues, starch, slaughter house refuse, tars and pitches from coal, natural asphalts and petroleum products.

The use of inorganic binding materials, such as those mentioned above, is not likely to prove practicable.

The use of clay, lime, and cements as binding materials was found entirely unsatisfactory, for the reason that they add largely to the ash constituent of the briquette. The briquettes made with these materials as bond went to pieces on exposure to water and weather, and their waterproofing, by soaking in oils, etc., was found difficult and expensive. In the tests with plaster of Paris, from 2 to 12 per cent of this material being used as a binder, the briquettes made were hard but brittle, and quickly disintegrated on exposure to moisture. None of the sugar-factory residues, namely, beet pulp, lime cake, beet-sugar molasses, and cane-sugar molasses, were considered satisfactory as binding materials for the reason that the briquettes made with them disintegrate on exposure to the weather, and no inexpensive waterproofing has as yet proved satisfactory on a commercial scale. Nor were any of the wood products, including rosin, pitch, pine-wood tar, hard-wood tar, Douglas fir tar, wood pulp, and sulphite liquor from paper mills when used alone regarded as satisfactory, though some of these materials used in combination with other binders gave results of some promise, and deserve further investigation.

The test made in which 0.5 to 3 per cent of starch was used as a binding material with different coals gave briquettes which were strong, burned smokelessly and held together in the fire until completely consumed. These briquettes, however, went to pieces when wet or exposed to the weather for a considerable time. Experiments as to the possibility of cheaply waterproofing these briquettes were sufficiently successful to warrant investigation in this direction.

Slaughter house refuse proved unsatisfactory for a number of reasons.

The tests with coal tars and the different grades of pitch made from these tars indicate that probably in the pitches the most satisfactory binders for the manufacture of briquettes will be found; and that these can be made at such a price as will bring the cost of the binding material used to not more than 50 to 75 cents per ton of briquettes. In the investigation of the asphalts as binding materials, impsonite from Indian Territory was found to be rather unsatisfactory, though in a number of tests with non-coking coals the result was improved by the addition to such coal of from 5 to 10 per cent of impsonite in addition to from 3 to 5 per cent of ordinary pitch or some other binding material. From 4 to 8 per cent of gilsonite and other asphalts from Utah gave fairly satisfactory results as a binder. This material is said to exist in Utah and elsewhere in large quantities, and while the price is at present too high to permit its extensive use as a binder, doubtless should the demand for it in this connection increase the deposits would be opened up to such an extent that it might be sold at lower prices. Experiments were made with several other asphaltic materials, and though the results were such as to warrant further investigation they were not altogether satisfactory. Asphaltic tar yielded fairly good results as a waterproofing material in briquettes made with starch. Asphaltic materials yielded the best results in waterproofing.

Crude petroleums have been tested as binding materials, with satisfactory results. The asphaltic petroleums were used successfully in waterproofing briquettes made with a starch binder, though it is doubtful whether this practice would prove entirely satisfactory in operations on a commercial scale.

Water-gas tar, which is obtained from illuminating gas plants, was not tested sufficiently to give satisfactory results, but it is believed that this material could be used as a binder if properly mixed with other somewhat similar materials. It is necessary, after this material is mixed with the coal, that the mixture should be raised to a sufficiently high temperature to liquefy and perhaps even to vaporize the tar. The cost of this binder would be from 45 to 65 cents per ton of briquettes.

TEST OF THE LEA-DEGEN TWO-STAGE CENTRIFUGAL PUMP.

Report by Prof. James E. Denton, of Stevens Institute of Technology.

For about two years Messrs. Julius Degen and E. S. Lea, Trenton, N. J., have been conducting experiments and taking out patents on centrifugal pumps, with the view of increasing their efficiency and at the same time reducing the cost of manufacture. Under the present condition of manufacturing ordinary centrifugal pumps a set of patterns is required for each size of pump, which, of course, means a great number of patterns to cover the requirements of pump users. The Lea-Degen design simplifies the problem by dividing the pump casing horizontally (for the purpose of assembling and examination) and vertically in the plane of each runner for the purpose of making a pump consist of as many runner units as are required for the character of service. They have succeeded in so designing their patterns that approximately 150 sizes and capacities of pumps are produced with ten sets of patterns. An interesting feature of this pump, referred to in our July, 1905, issue, is the method employed for balancing. This will be described later on in the account of the test. The following is an account of a test made by Prof. James E. Denton, of Stevens Institute of Technology, dated July 24, 1905.

General Description of the Pump.

The general design of the pump tested is exposed by Figs. 1 and 2, which show it to consist essentially of two shrouded runners, or pump wheels, mounted on the same shaft in a double case. The case is so partitioned that the water is drawn from the source of supply and put under pressure by the first wheel, and then delivered to the suction chamber of the second wheel. The second wheel then imparts to the water the same amount of energy it receives from the first wheel, thereby increasing the pressure, and then delivers the water into a spiral discharge conduit terminating in a diverging nozzle connecting with the main pipe. The outline dimensions of the pump follow:

Diameter of suction pipe	10 inches
Diameter of discharge pipe	10 inches
Outline diameter of each wheel	24 inches
Number of blades	8

Novel Features of the Pump.

The special features of the pump which represent patented advantages are as follows:

1. The case is divided through its horizontal diameter by bolted flanges so that its top half can be quickly freed, and lifted off, without disturbing either suction or discharge connections, thereby affording easy access to the internal parts of all the stages at once.

2. By means of bolted circumferential divisions of the case, provision is made for either using the suction and discharge end of a case together as a single-stage pump, or for adding as many intermediate sections as may be necessary to afford any desired pressure at any fixed speed. Additional stages can therefore be installed after a pump has been in operation without wasting any parts of the existing case.

3. A special arrangement of double cup-leather packing is used for both the suction and discharge ends and for the intermediate sections. The cup leathers are held against a flat collar, on extended pump-wheel sleeves, in such a manner that the leathers can follow up as they or the collars are worn, or the shaft may be shifted at will in either direction, with the leathers following, without changing the location of the leather with relation to the shaft collar, thus making a practically water-tight joint at all times. A spiral spring is used, between each pair of cup leathers, to insure their seating against the collars before pressure is put on the pump. Provision is made for setting out the leather packing on the suction end of the shaft by the water pressure of the high side of the pump.

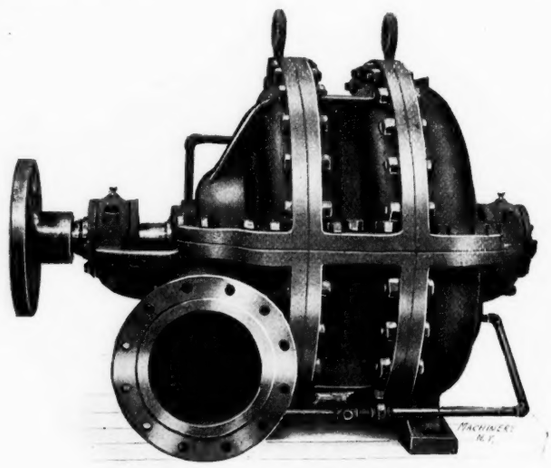


Fig. 1. Lea-Degen Centrifugal Pump. Note "Unit" Design of Shell Parts.

4. On the outside of main bearings, at each end, is placed a ball thrust-bearing, with adjusting collars, for shifting the shaft endways to balance the end-thrust of the pump runners. The balancing is accomplished by means of variation in the width of water space, on both sides of the wheels between the rim of wheel and the case. Experiment showed that as the wheel was moved laterally in the case, the pressure between the wheel and case increased on the side where the clearance was greatest, and was reduced on the opposite side.

General Description of Tests.

The pump was driven by a General Electric direct-current multipolar dynamo of 385 amperes and 220 volts' capacity used as a motor, and directly connected to the pump shaft.

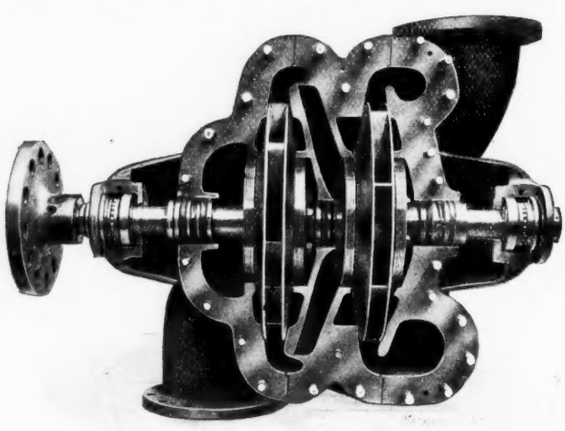


Fig. 2. Lea-Degen Centrifugal Pump, showing Runners.

It was arranged (Fig. 3) to lift water by suction, about seven feet, from a well fed from the Raritan Canal, and to deliver it through a 10-inch throttle valve, *C*, to a 6½-inch bell-shaped nozzle, *H*, to a weir tank, *M*, which was about 25 feet long by 10 feet wide and 10 feet deep, whence the water flowed through a rectangular notch 3.02 feet wide in a ¼-inch beveled iron plate, *L*, set in the middle of the end of the tank about 7 feet above the bottom.

A pitot tube, *I*, was applied under the nozzle, and its indica-

tions used as a means of quickly adjusting the discharge of pump to the several amounts of flow necessary for the tests.

The amount of water flowing was calculated from the weir height by the Francis formula:

$$Q = 3.33\ (l - 0.2\ h)\ h^{\frac{3}{2}}$$

The weir heights were taken with a hook-gage, *O*, in a barrel, *N*, communicating with the tank by a 2-inch pipe, *P*, having an open end square with the flow of water at a point 13 feet back of the notch. The surface of the water approaching the weir was made perfectly smooth by means of a grill lattice 6 feet from the discharge nozzle, and dam-boards set by trial.

The zero of the hook-gage was determined daily with a straightedge and checked by a surveyor's level. Readings of the gage could easily be made to 1-64 inch. The leakage of the weir was frequently determined. It remained practically constant at 18 gallons per minute, which was added to the quantity calculated by the weir formula.

At each speed the steps in the determination of the maximum efficiency were as follows:

The pump was primed† with the throttle valve *C* (Fig. 3) closed.

The throttle valve was then set wide open, and connection made with the mercury columns, which had been previously filled with water between the mercury and the cock connecting them to the main pipe. The speed was then adjusted by a rheostat, and the required data were observed at five-minute intervals until the average of the readings was practically constant. The throttle valve was then reset to secure a series of reduced rates of flow, which, by preliminary tests, were known to be sufficient to establish the "gallons-lift" curve (Figs. 4, 5 and 6). No data were recorded at a speed varying more than two revolutions from the assigned speed, a skilled assistant devoting his attention to this point. After the "gallons-lift" curves were secured, the pump was disconnected from the motor, and the power of the latter absorbed

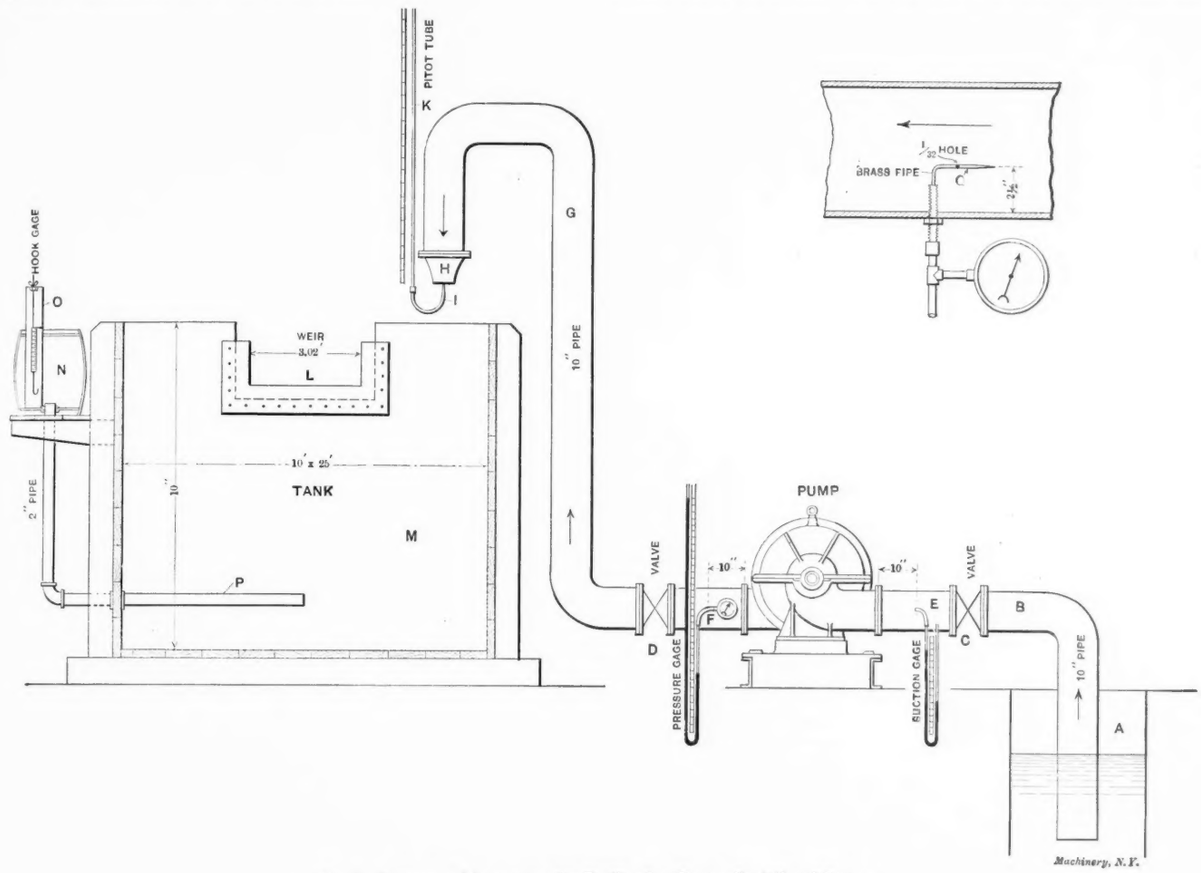


Fig. 3. Diagram of Apparatus for Testing Lea-Degen Centrifugal Pump.

The total lift of the pump was determined by adding the vacuum shown by a mercury gage, *E*, to the pressure above the atmosphere shown at *F*, the pipe diameter being the same at both points.

At *F* both a pressure gage and a mercury tube were used during most of the tests, the gage being calibrated by a Crosby testing apparatus. To secure a smooth surface in the main pipe for measuring the pressure at *E* and *F* the latter was taken through a 1-32-inch hole, *Q* (see sectional view), in the top of a ¼-inch polished brass tube,* with a pointed closed end lying against the current.

Method of Procedure.

The pump was designed by Mr. Degen for practically equal efficiency for the range of speed between 400 and 600 revolutions per minute. Therefore, an efficiency test was made at 400, 500, and 600 revolutions, respectively.

by a prony brake over the same range of watts applied to drive the motor during the pump tests. Thereby the "brake horsepower-watts" curves‡ (Fig. 7) were established.

From these curves the horsepower corresponding to the watts applied to drive the motor during the pump tests, was determined, and taken as the horsepower to drive the pump (column 6, tables 1-3).

The useful work of the pump is (column 5),

$$\text{Water horsepower} = \frac{\text{Pounds water delivered per minute} \times \text{total lift in feet}}{33{,}000} =$$

$$0.000252 \times \text{gallons per minute} \times \text{total lift in feet.}$$

The total lift is the sum of the suction vacuum (column 4), and the pressure (column 3), in front of the throttle valve, expressed in feet of water.

* The tube was located 2½ inches from the side of the pipe. Experiment showed that at the highest rate of flow there was an increase of ½ pound pressure when the 1/32-inch hole was moved from a point 3⅞ inches inside the pipe to a point ½-inch within it. The position of the tube in the pipe is not a factor in the test since it was the same at *E*, and *F*, and the velocity was equal at these points.

† The priming was done by water from the city mains acting through a 1¼ Penberthy ejector, no foot-valve being used on the suction pipe.

‡ For 400 and 500 revolutions these curves are straight lines, but at 600 revolutions, the straight line does not maintain, probably because the speed had to be regulated by changing the position of the brushes.

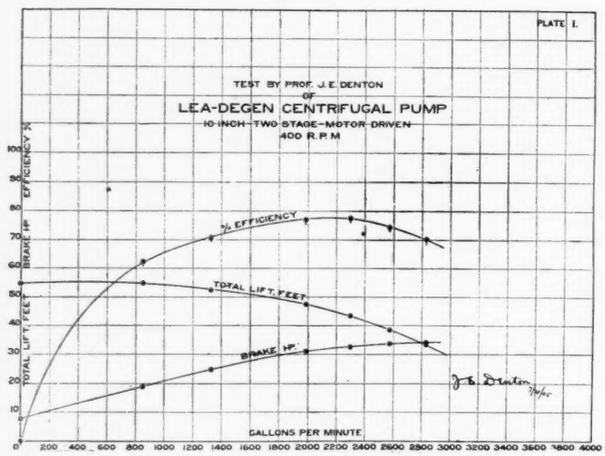


Fig. 4. "Gallons-lift" Curve for 400 R. P. M. Lea-Degen Centrifugal Pump.

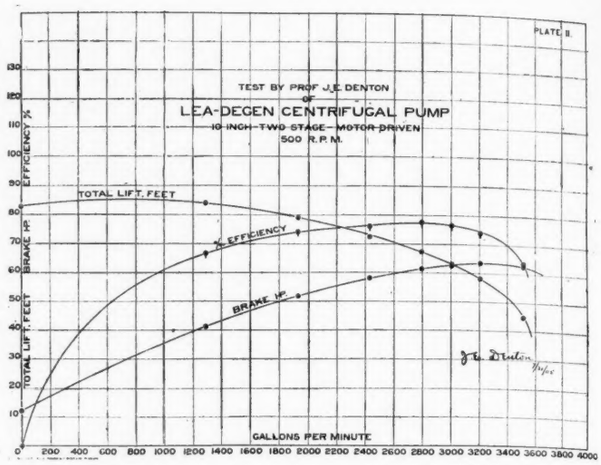


Fig. 5. "Gallons-lift" Curve for 500 R. P. M. Lea-Degen Centrifugal Pump.

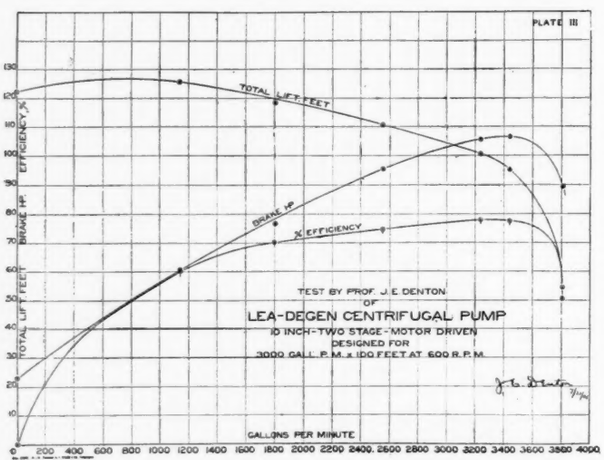


Fig. 6. "Gallons-lift" Curve for 600 R. P. M. Lea-Degen Centrifugal Pump.

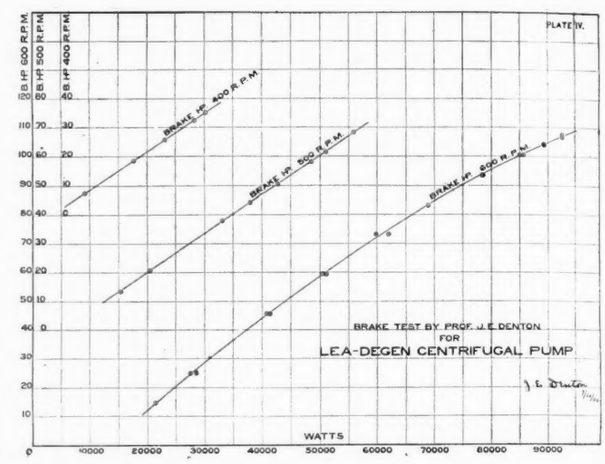


Fig. 7. "Brake-horsepower watts" Curve, Lea-Degen Centrifugal Pump.

RESULTS OF PUMP TESTS.

Table I. 400 Revolutions.

Weir Gallons per min. G	Total Lift, feet.	Outlet Press, feet.	Suction Lift, feet.	Water Horse Power	Horse Power to Drive Pump.	Weir Height, feet. h	Pitot Ratio, C	Watts to Drive Motor.	Revolutions per min.	Efficiency. E
1	2	3	4	5	6	7	8	9	10	11
2828	33.65	20.29	13.36	24.08	34.22	0.754	0.982	29,830	401	70.37
2574	38.55	26.32	12.33	25.10	33.78	0.707	0.981	29,484	402	74 30
2296	43.63	32.41	11.22	25.34	32.61	0 653	0.988	28,576	400	77.70
1984	47.49	37.29	10 22	23.84	30.96	0.590	0.992	27,300	401	77.00
1328	52.39	43.98	8.41	17.60	24.86	0.448	.....	22,570	401	70.79
852	55.00	47.69	7.31	11.86	19.02	0 330	.....	18,042	401	62.42
0	54.93	48.16	6.77	0	7.7	0.0	.....	9,400	402	0

Table II. 500 Revolutions

3517	44.81	27.85	16.96	39.87	62.58	0.878	0.965	51,700	501	63.71
3207	58.09	43.17	14.92	47.13	63.64	0.823	0.987	52,496	500	74.05
3005	63.12	49.28	13.84	47.99	62.63	0.787	0.984	51,736	500	76.62
2794	67.44	54.48	12.96	47.67	61.41	0.748	0.996	50,830	500	77.62
2428	72.38	60.84	11 54	44.46	58.16	0.678	0.995	48,400	500	76.04
1929	79.09	69.26	9.83	38.60	51.99	0.578	0.989	43,800	500	74 24
1289	84.26	76.16	8.10	27.48	41.11	0.438	.....	35,680	501	66.84
0	83.04	76.27	6.77	0	12.07	0.0	.....	14,012	502	0

Table III. 600 Revolutions.

3806	50.65	32.11	18.54	48.58	89.40	0.928	0.974	74,365	600	54.34
3440	95.13	34.10	16.36	82.47	106.50	0.864	0 973	92,115	600	77.44
3235	100.71	36.97	15.31	82.10	105.30	0.828	0.987	91,052	600	77.97
2554	110.46	42.45	12.40	71.09	95.40	0.703	0.997	80,220	600	74.52
1805	118.21	46.95	9.76	53.77	76 60	0.553	0.998	63,300	598	70.19
1139	125.67	50.90	8.09	36.07	60.10	0.401	.....	51,012	599	60 02
0	122.08	49.80	7.04	0	22.90	0.0	.....	26,880	600	0

The efficiency is then (column 11):

$$E = \frac{\text{Water horsepower}}{\text{Horsepower to drive pump}}$$

The prony brake was of the two semi-circular, solid-block type applied to a 28-inch pulley, with a 6-foot lever-arm acting on a knife-edge on a tested platform scale. It was carefully balanced, with its pulley, by mounting the whole com-

bination, with a mandrel through the pulley, on straightedges. A copious stream of water applied to a nipple in the top block, through a long vertical flexible hose, and a hand-tightening wheel, with a leverage of 1,000 to 1, enabled the highest loads to be maintained indefinitely with a very steady equipoise of the scale-beam. The electrical readings were made from a Weston instrument from the laboratory of the Stevens Institute.

The ratio of the quantity of water given by the weir to that given by the pitot tube is shown in column 8. This ratio is the value of the coefficient C in the formula for cubic feet per second.

$$Q = C \times \text{area of nozzle} \times \sqrt{2g \times \text{pitot head}}.$$

Conclusions.

The tests show that the pump afforded the following results under conditions of maximum efficiency:

At 400 revolutions, 77.7 per cent efficiency, with a capacity of 2,296 gallons under 43.6 feet lift.

At 500 revolutions, 77.6 per cent efficiency, with a capacity of 2,794 gallons under 67.4 feet lift.

At 600 revolutions, 77.97 per cent efficiency, with a capacity of 3,235 gallons under 100.7 feet lift.

In round numbers, therefore, the capacity at maximum efficiency is directly proportional to the revolutions, and the lift, or head, is proportional to the square of the revolutions. At each speed the efficiency averaged more than 76 per cent over a range of 600 gallons of capacity for the lower two speeds, and 900 gallons at the higher speed, the head remaining nearly constant.

Test of Effect of Altering Clearance upon the End Thrust.

Pipes tapped into the case on either side of the high wheel were connected to the two ends of a U mercury tube. With the shaft in the position in which it had been adjusted for the test, there was no difference of pressure shown by the mercury, and there was no evidence of labor in the thrust bearings for this position during the several days of operation of the pump for the tests of efficiency. When the shaft was moved 7-32 inch laterally from this position, the mercury showed an excess of pressure of ⅞ inch on the side of the wheel upon which the clearance had been increased.

[The balancing chambers on either side of the wheel are in communication with the annular discharge space surrounding the circumference of the wheel, communicating therewith by the clearance spaces referred to. If these clearance spaces are considered to be of considerable width it is clear that a pressure equal to that in the annular discharge space will exist in the balancing chambers, but if the clearance on one side of the wheel becomes smaller, owing to lateral movement of the runners, there will be a reduction of pressure on that side due to the sucking action of the jet of water emanating from the mouth of the wheel. This sucking action, therefore, will, reduce the static pressure of water in the balancing chamber on the side having the clearance reduced, or, putting it as above, the pressure will be greater on the side which has the greater clearance. The arrangement for balancing the end thrust is, therefore, not an automatic one, in the sense that the runners seek a balanced position; the shaft and runners are adjusted by hand until the end thrust is zero, and is then kept in this neutral position.—EDITOR.]

MACHINERY COMPETITION OF UNITED STATES AND GREAT BRITAIN.

Consular Report No. 2665.

The two great machinery-producing countries of the world are the United States and the United Kingdom. The American leadership has been in new and skillful mechanisms to save labor costs, the British in bulk of production and export. Both countries are rapidly increasing their foreign sales, as the following tables of comparison indicate, the American statistics being for the fiscal year ending June 30, 1906, which show 18 1/3 per cent increase over 1904, while the British figures of export for the first six months of 1906, show 24 1/3 per cent increase over the same months of 1904.

Great Britain does not compete with America in the trade for cash registers and typewriting machines, laundry, shoe, and pumping machinery. In other lines competition between the two countries is keen. The United States exports of locomotives increased by 20 per cent from 1904 to 1906, while British exports increased 35 per cent. The most notable American increase was in the Central American States, where $37,150 worth of locomotives were sent in 1904, $60,810 in 1905, and $1,131,930 in 1906, while sales to Japan increased from $624,873 in 1904, $1,276,045 in 1905, and $1,996,398 in 1906.

AMERICAN EXPORTS, FISCAL YEAR ENDING JUNE 30.

	1904.	1906.
Cash registers	$1,836,233	$2,496,891
Electrical machinery	5,645,809	7,869,137
Laundry machinery	553,912	674,398
Metal-working machinery	3,716,709	6,445,612
Printing presses	1,396,746	1,577,061
Pumping machinery	2,703,397	4,210,624
Sewing machines	5,623,423	7,272,868
Shoe machinery	1,071,090	1,487,140
Locomotives	5,261,422	6,375,229
Boilers and engine parts	2,169,753	2,484,003
Stationary engines	1,069,401	1,485,093
Woodworking machines	738,609	945,832
Typewriting machines	4,537,125	5,126,374
Agricultural machinery and implements	22,749,700	24,554,427
Other machinery	19,906,662	28,437,235
Total	78,979,981	93,448,397

BRITISH EXPORTS, FIRST SIX MONTHS OF YEAR.

	1904.	1906.
Locomotives	$4,511,480	$6,418,570
Agricultural engines	2,499,887	2,782,545
Other engines	5,452,889	9,068,169
Agricultural machinery	2,582,068	2,904,891
Sewing machines	5,615,065	3,790,838
Mining machinery	2,138,014	1,757,201
Textile machinery	11,627,723	15,339,841
Electrical machinery	1,045,587	2,132,797
Other machinery	14,656,604	20,641,474
Total	52,129,317	64,836,326

* * *

TURBINE TROUBLES NOT SERIOUS.

In your issue of June, 1906, you devote some space to turbine troubles. I trust I may be pardoned for calling your attention to the prominence which you have given to certain of them. Quoting:

"The most serious trouble experienced with the Parsons turbine has been the tearing out of more or less of the blading upon occasions when the rotor and stator came into contact through some accident or otherwise."

Appearing at the beginning of this article this would lead one to the belief that the trouble was really very serious indeed, and was to be expected at any moment, a state of affairs which would not be altogether conducive to the peace of mind of a power plant manager who had to depend absolutely upon his turbines.

Now, no one will deny that blading troubles have occurred in the past and will occur now and then in the future from various causes, just as the flywheels break, connecting-rods give out, bearings get hot, cylinder heads crack, etc., in a steam engine that does not get proper attention. But it is important to bear in mind that blading troubles, while sometimes serious in themselves, are quite insignificant in proportion to the total experience that has been achieved in the turbine art.

As an example of the relative unimportance of blading trouble as compared with the breaking of similar parts in a steam engine (even so small a break as a piston ring), several cases may be cited in which a number of rows of blades have been lost while the machine was in service without being observed by the attendants and with no noticeable effect on the running of the machine. In one case blades were out for a period of several weeks without the turbine having been opened up for inspection or otherwise given more than ordinary attention. Furthermore, the effect on the capacity of the turbine is usually not felt except, of course, when the machine is operating near the limit of its capacity, which is rarely the case. As the Parsons type of turbine is a balanced machine, the rotor is always in equilibrium, the internal pressures adjusting themselves automatically, which makes

it possible to run with some blades out. The usual practice in cases of blading trouble is to temporarily remove the injured material, replace the cover and put the machine back into service until such time as repairs can conveniently be made, which is usually at night. If the work cannot be completed at one time, the machine is again assembled and continued in service until a further opportunity is available to work on it. These conditions are evidently not so "disastrous" as inexperienced opinion might lead one to think.

There is at the present time a prevalent and most unfortunate tendency to make much capital out of small troubles, and the length to which enemies of the steam turbine have gone to expose some little failing, easily corrected, is truly remarkable and often ludicrous. In instances of this kind the broadest possible view must be taken to avoid attaching undue importance to unimportant things; and the technical press can in no more effective manner demonstrate its beneficial powers than by rigorously sifting all reports savoring of undue pessimism.

Reverting again to your article, you mention the effect of vacuum in inducing heavy stresses upon the turbine casing. Now it is evident that the stresses upon a turbine casing from atmospheric pressure are quite balanced in all directions with the exception of the net area of the exhaust passages to the condenser. But the resultant downward pull is taken up directly by the turbine pedestal in either of several ways; in one, the rear footing of the turbine casing is made integral with the exhaust passage so that the excess pull exerted upon the casing is transmitted to the foundation through the rigid metallic structure at the exhaust end; in another construction the rear turbine footing is carried up as far as the main horizontal flange on the turbine casing and quite independent of the exhaust nozzle. This results in the excess pull due to vacuum being transmitted still more directly to the foundation.

As to the effect of the condenser weight, it is a more important matter to provide for variable expansion of the exhaust nozzle and connecting piping when operating on different vacua and for the possible settling of the condenser foundation. In numerous instances this has occurred, resulting in undue stress upon the turbine casing. The obvious remedy is a corrugated copper expansion joint, and on all but very large sizes of steam turbines, it is the customary practice to supply these expansion joints. It is well to remember that an installation when it is first erected may be most accurately attuned in all its parts, but how few installations of this character are gone over semi-annually, or even annually, for the purpose of checking adjustment and alignments to determine whether foundations have settled equally. Heavy stresses, often of dangerous proportions, may have developed in the interim, without giving the least external evidence.

East Pittsburg, Pa. J. R. BIBBINS.

* * *

THE A. L. A. M. STANDARD SCREWS AND NUTS.

The Association of Licensed Automobile Manufacturers some little time ago appointed a committee to investigate the subject of standard screws and nuts. These manufacturers have found, as have some other makers of high-grade machinery, that the United States or Sellers standard threads give pitches somewhat coarser than are desirable. Finer pitches have therefore been employed, each concern fixing a standard of its own. The resulting confusion has been a great annoyance to dealers, repair men, and the makers themselves, and it was to remedy this condition that the committee was appointed. Their report (of which the essential features are given in the supplement accompanying this issue of MACHINERY) has just been made public.

The shape of the thread is still that of the United States standard with straight V sides at an angle of 60 degrees, the top being flatted to one-eighth of the pitch and the bottom filled in by a like amount. The number of threads per inch has been made approximately half as many again, and the dimensions of the "hex-headed" nut, and head of bolt or "screw," as the report prefers to call it, have been made considerably smaller. The thickness of the head has also been decreased in both the case of the nut and the screw head. It has been definitely determined by experiment, however, that this thickness is amply large enough to compel the bolt or screw to fail by rupture in tension through the root of the thread just under the nut, the samples tried in no case failing by shearing of the threads, a condition which is, of course, as it should be.

A better material than that ordinarily used for screws is deemed necessary. The selection of a better material depends to a considerable extent upon the possibility of commercially machining it in screw machines, and such material has been found in several qualities of steel, having a tensile strength of not less than 100,000 pounds per square inch, and an elastic limit of 60,000 pounds per square inch, as compared with 50,000 or 60,000 pounds per square inch tensile strength and 35,000 pounds per square inch elastic limit now in common use. This material is also very much tougher, being lower in impurities and showing a very fine fracture, characteristic of a tough steel. As regards the destructive tests of tensile and shearing strength above mentioned, they were made both with ordinary material and with the material it is proposed to use for automobile work. The results were the same in both cases; that is, the screw broke at the base of the thread inside the nut.

The Association of Licensed Automobile Manufacturers, in the circular letter sent out with the report, say: "It is nothing revolutionary in any sense of the word, but, on the contrary, it conforms to the general practice of many machine tool and automobile builders. Like any new standard, it cannot be hoped that it will be adopted immediately or universally, but it is believed that it will gradually creep into use. As time goes on, it is probable that these screws will be found in stock just as the ordinary United States standard is now found. This cannot be done immediately; it must be accomplished by merit; that is, merit in this standard."

* * *

GOVERNMENT SUPERVISION OF SMALL DISTILLERIES IN GERMANY.

A consular report from Germany describes the method used by the German government in supervising the manufacture of denatured alcohol. There are some 70,000 farm distilleries in Germany and the problem of the government in supervising this immense number of small establishments would be a serious one if the same methods were followed that are used in the larger establishments. This is not done, however. The stills have to be made in a certain way, which includes a tank that can be locked with a government lock and sealed with a government seal. The small farm distilleries operate in the winter when the farmer has leisure to do something else than straight farm work. The farmer has to give the government thirty days' notice as to the time he wants to begin to operate his still. Some time during the thirty days an inspector comes along and looks the still over to see that it is clean, etc., and then he locks and seals the tank, after which the still is ready for the farmer. He may go ahead and distill until the tank is full. Then he informs the person who is to buy the alcohol from him, after which he notifies the government, and an inspector comes and removes the seal, measures the contents of the tank, and collects the revenue. If the farmer wants to denature the alcohol on the spot he can do so in the presence of an inspector, when the amount of the tax will be returned to him. But generally the farmers sell through the great central selling agencies, which denature at a central point and in large quantities, and collect the rebate from the government in considerable sums.

* * *

The year ending August 31, 1906, has been one of remarkable growth in the railroad department of the Young Men's Christian Association. Sixteen new railroad association buildings have been opened and ten other new associations have been organized, two of them among street railway men, making a total of 225. The membership is over 81,000 and there are now 149 buildings owned and occupied having a total valuation of $2,601,350. In addition sixteen other buildings are now being constructed at a cost of $538,000, and these when completed will make 165 buildings with a total valuation of $3,139,350.

NEW PLANT OF THE BOSTON GEAR WORKS.

The Boston Gear Works have erected a new shop for the production of gears at Norfolk Downs, Mass., a suburb of Quincy, six miles out from Boston on the Plymouth division of the New York, New Haven & Hartford R. R. The company, of which Mr. Frank Burgess is the animating spirit, has been located for the past seven years at 152 Purchase St., Boston, Mass., and they will still maintain the Boston office at 102 High St.

The main building, Fig. 8, is approximately square, being about 100 feet wide by 125 feet long, one story high with sawtooth roof. There is a second story over the middle portion of the shop which is given up to the drafting room and offices for the clerical force. The building is exceptionally well lighted by large windows in the sides and the windows in the saw teeth of the roof, which face the north. The sides of the shop are covered with galvanized-iron clapboards.

The management of the shop consists of a central expert authority which controls the different departments through experienced men known as "jobbers." These men issue the orders for work to the shop directly, each handling those orders for which he is best fitted by experience and training. The machines are in charge of foremen who bear the same relation to the superintendent that the jobbers do to the central head before mentioned, and these follow personally the different jobs entrusted to them.

The worm gear department is equipped for the production of all classes of this style of gearing, many of the machines being of special design built by the firm for their own use. Hobs used for cutting teeth of worm gears are made in the toolmaking department and general use is made of high-speed steel for this work. This department is illustrated in Fig. 1.

The spiral gear and worm department, illustrated in Fig. 2, is equipped with a full line of machinery, and a specialty is

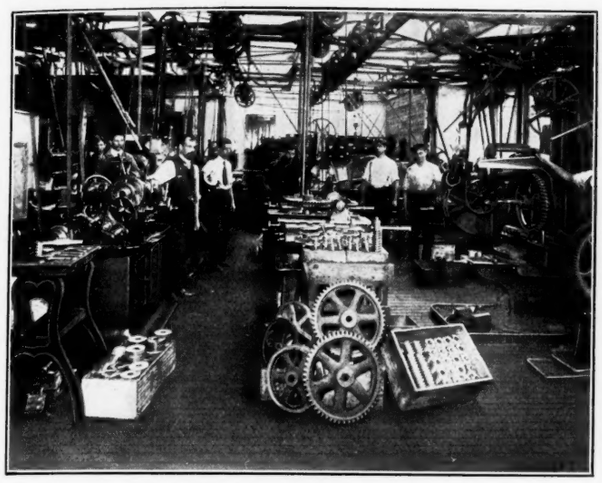


Fig. 1. Worm and Worm Gear Department.

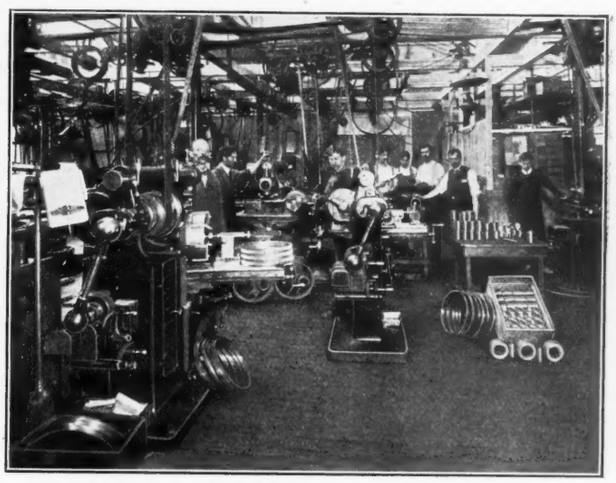


Fig. 2. Special Machinery for Cutting Helical Gears.

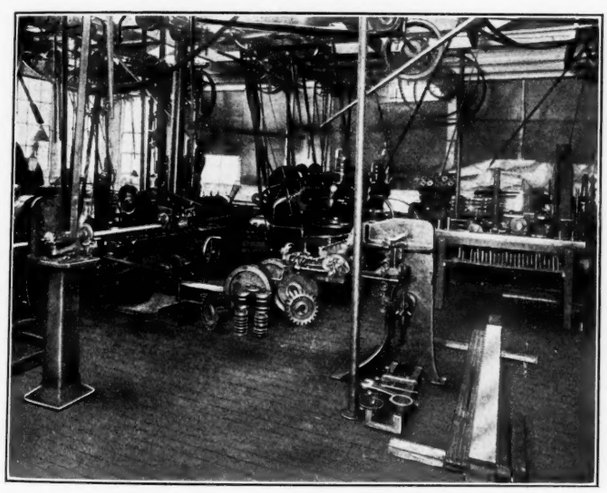


Fig. 3. Gear and Rack Department for Planing and Generating Spur Gear Teeth.

Fig. 4. Automatic Bevel Gear Planing Section.

The motive power of the shop consists of two Hornsby-Ackroyd oil engines of 25 H.P. each. These are ordinarily run together, but may be run separately when occasion requires. A pump circulates hot water through the shop for toilet and cleaning purposes. Cold water at 80 pounds pressure is supplied by the Quincy Water Works.

The shop is classified into departments as follows: Worm gear department; spiral gear and worm department; spur gear and rack department; bevel gear department; toolmaking department; screw machine and automatic machine department; lathe department; brass model gear department; automobile department; polishing department; stock department; case-hardening department; testing department, and pattern department.

made of all forms of spiral and helical spur gears and worms. This style of gearing is made to run at any required angle of shafts or with parallel shafts and at any speed ratio.

The spur gear and rack department shown in Fig. 3 also embraces the cutting of intermittent, elliptic, skew bevel and internal gears, ratchets, clutches, crown wheels, etc. At the extreme right in Fig. 3 is shown a spur gear machine with micrometer adjustment which gives the required center distance within 0.0005 inch of accuracy. This department is, of course, the largest cutting department in the factory. It is equipped with modern automatic machinery for generating the teeth of racks and spur and internal gears theoretically correct, these machines being of the Fellows type.

The bevel gear department shown in Fig. 4 is equipped

with Gleason gear planers and other machines for the accurate production of bevel and miter gears. A specialty is made in this department of automobile driving and differential gears and large contracts are made with various automobile manufacturers for gearing which they are not equipped for producing in their own shops.

The making of cutters, hobs, tools, and cutting of cams and repairing and building of machinery is done in the toolmaking department. All special tools, jigs, gages, etc., are also kept in this department.

Fig. 5 illustrates the screw machine department, which is equipped in the regular manner with turret lathes and automatic screw machines, and besides with a number of special attachments built by the firm for work of special character.

The brass model gear department is devoting itself to the manufacture of small work, such as pinion wire, clockwheels,

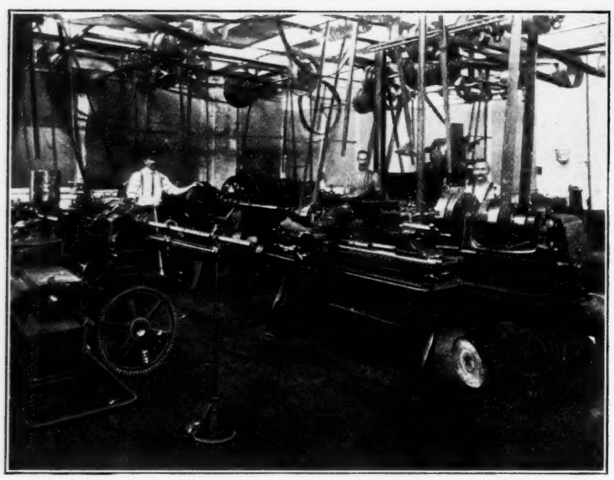


Fig. 5. Turret and Automatic Screw Machine Department.

ratchet wheels, etc., and in fact contains machinery of all descriptions to be found in the other departments, except that these machines are designed for very small work. Orders in this section frequently run up to 25,000 pieces.

The automobile department, illustrated in Fig. 6, has derived its name from the fact that the "safety steering device," manufactured by the firm, is made principally in this department. This department also comprises the general machine department, where tools of a general character, such as engine lathes, etc., are placed.

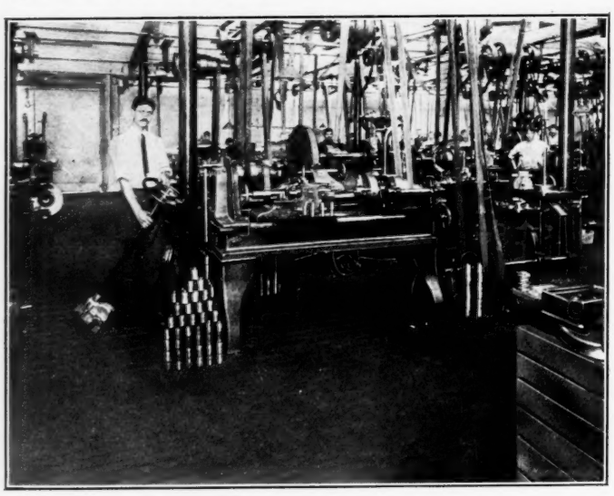


Fig. 6. General Machine and "Automobile" Department.

Fig. 7 shows the testing department, located in the center of the shop. This department stands under the direct supervision of the superintendent, and is conducted by the foremen of the various departments. It is well equipped for testing the products of the firm to very close limits, a number of devices having been designed particularly for this purpose.

The cost system of the shop is organized with a view of giving at once and in detail the cost of any job passing through the works. Accurate records of the time used on each job are turned in every day by the respective foremen.

The comfort and requirements of the employes has been taken in due consideration. The factory is provided with a

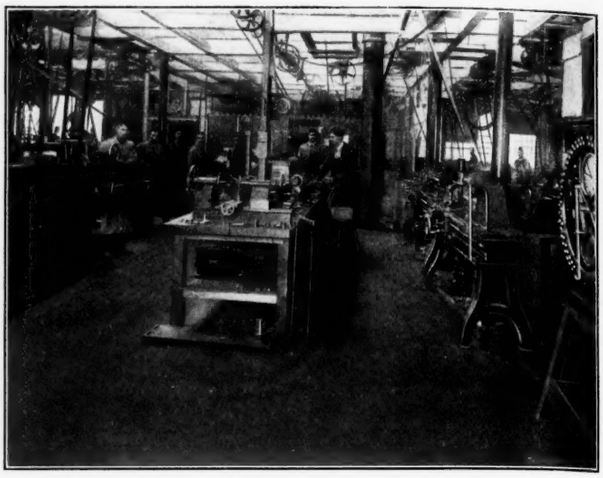


Fig. 7. View showing Testing Department and Tool Stock Room; Dey Time Clock at the Right.

lecture room, and with a large wash room with hot and cold water and individual lockers, each having its own key. The factory is, in fact, perfectly modern in its equipment in all respects, and very few things indeed seem to have been overlooked in its planning and construction.

* * *

ELECTRICAL STEEL MELTING FURNACE.

The primary difficulty with electrical steel melting has been that the use of electrodes has changed the composition of the metal. This difficulty seems to have been overcome in the new electrical furnace installed by Henry Disston & Sons at their Tacony works near Philadelphia, Pa. Briefly, the furnace is an electric transformer in which the metal to be

Fig. 8. General View of Boston Gear Works.

melted is arranged in a closed ring form, the crucible being in the shape of an annular ring. The crucible encircles the central portion of a laminated iron core which extends across the top, two sides and bottom of the crucible, constituting a closed magnetic circuit. An alternating current of low amperage is passed through a conductor surrounding the central portion of the iron core. With each alternation of current in this primary conductor a current of electricity is induced in the metal placed in the annular cavity of the crucible, by means of which the melting of the metal is effected. There is no contact between the primary and secondary circuits and there are no electrodes, consequently no alteration occurs in the metal operated upon. The steel is melted by the heat developed within its own mass by the passage of the induced current. The tests thus far made prove conclusively that the electrically melted steel fully meets the requirements of the highest standard of quality. It has been subjected to the usual chemical and physical tests and has been used in the manufacture of several of the products of the company. As far as the quality of the product is concerned it may also be noted that since the metal is melted in the absence of fuel gas it yields a very dense and fine-grained casting and its final composition is dependent solely upon the predetermined composition of the material.

MILLING OPERATIONS.

JOHN EDGAR.

In the editorial "The Value of the Camera as an Instructor" in the September issue, the editor in commenting on the article by Mr. Fairfield on "Planing a Small Machine Part," holds out the view that the milling machine could not perform the work in a very successful manner as compared with the planer. This of course leaves room for an argument, and being of a "butt in" nature, I feel that it is up to me to keep my record and try to show that the milling machine can handle the particular piece of work successfully in comparison

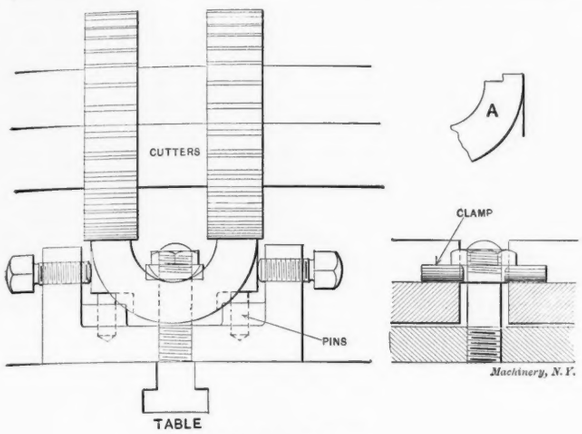


Fig. 1. Milling the Cap.

with the planer, both in regard to finish and accuracy. It is mainly on just such work as this that the milling machine has proven its great advantage in the economical production of machine work. Why the editor singled out this particular job is beyond my comprehension.

Taking the cap first we may hold it in a manner similar to that shown by Mr. Fairfield in his photographs and the operation may be performed on almost any style of milling machine. Take the plain miller, use two narrow plain cutters and hold the work in the vise; one or two cuts would be taken over the surface to be machined, using fast feeds with considerable depth of cut for the first cut, and a finer feed and higher speed for the final or finishing cut. A better surface cannot be obtained expending the same amount of time on a planer. The cutters must be in excellent condition in order to obtain good results, but the same applies to the planer

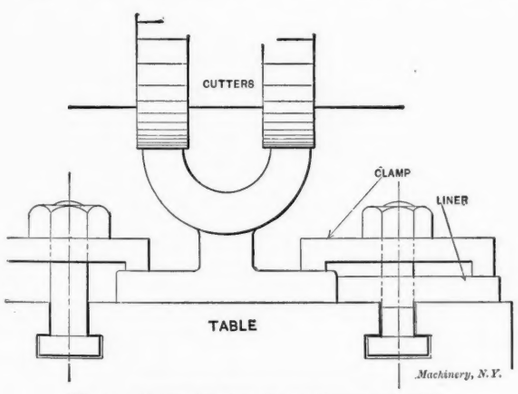


Fig. 2. Milling the Seat for the Cap on the Base.

tools as well. If we are manufacturing a large number of these pieces it will pay to make special fixtures for holding them, arranging them so that the extreme length of the table feed or travel may be used. We may arrange to take one or more rows of the castings side by side, depending on the size of the miller. This cap is a piece exceedingly easy to hold in a fixture such as shown in Fig. 1. The cap will be seen to be resting on pins where the bosses for the cap bolts come, this making a convenient and reliable foundation. The cap is held sideways by the setscrews on either side and is held down on the pins by the clamp shown in the sectional view. The drawing explains itself, so that but few words are necessary in connection therewith.

In the holding of work on the milling machine table or in supplementary fixtures it seems to have become the idea that it is necessary to bolt it down with all the force that it is possible to use without stripping the thread on the bolts. So much strain is not necessary, serving as it does only to distort the table, making it run hard and eventually producing a permanent set which gives the working surface an untrue face. This straining of the binder bolts also wedges the T-slots out of shape, peening the metal above the T so as to project above the rest of the surface. An examination of the machine in operation will show that in 90 per cent of the work done the force or pressure of the cut is symmetrical and has but little effect on the work, all the holding required being merely that necessary to keep it from sliding either along in front of the cutter or sideways. This is accomplished by bunters and toe clamps. Of course it is necessary that the work be held down on the platen, but very little power is necessary in doing so. Had the cap been made with the matched fit shown at A instead of the straight fit, the advantage of milling over planing would have been much more apparent, as gang cutters would have finished the work at one setting, while the planer would have required at least two. But the real gain would be in obtaining interchangeable work which can be obtained on the planer only at the expense of considerable time and trouble, but which is a matter of course on the miller.

In performing the corresponding operation on the base casting we have the advantage of the broad base and the projecting surfaces for clamping which make it an easy matter

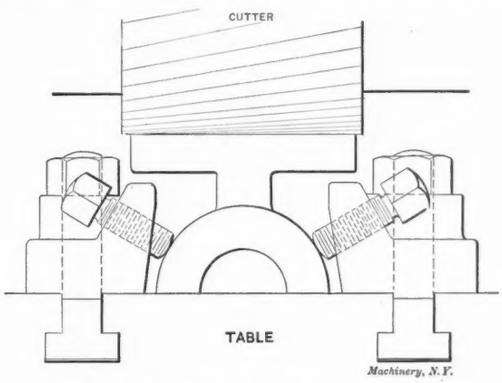


Fig. 3. Slab Milling the Lower Surface of the Base.

to set and hold the work. The same that has been said regarding the operations on the cap may be applied to the base. Fig. 2 shows how this piece would be held. The clamps hold down the piece, while the piece is blocked up against a liner to insure a setting parallel with the travel of the table. The row is kept from shifting endwise by using the bunters mentioned above. In machining the foot of the base piece we are confronted by a job that presents a kind of milling operation which has many little points of interest. The problem of milling comparatively broad surfaces is presented. It is an acknowledged fact that the milling of such surfaces must be accomplished by cutters that are so constructed that the chip is broken up into short cuts, giving the operation the advantage of the single pointed tool in the question of power required, and truth of surface obtained. This is accomplished by notching the teeth of the cutter so that they may be presented to the work successively, both notches and teeth being cut spiral at right angles with each other. A surface produced by such a cutter will bear the strictest examinations as to truth without being found wanting.

Fig. 3 shows one method of machining the bottom surface. In this method we use a plain milling cutter as shown, taking one or two cuts as the case may require. If very little stock has to be removed but one cut ought to be sufficient as the resulting surface will be good enough for the intended purpose. As will be seen the piece is held down and prevented from moving sideways by the screws which are tapped

through the strips bolted to the table. This makes a convenient method and one that will be found to answer the purpose very well. Another method of performing the operation is by the use of an end mill as shown in Fig. 4. This means of removing the metal is very efficient as a very true surface can be obtained with a much faster feed and deeper cut than can be done by slab-milling. The power necessary to revolve the cutter and force the feed is very much less than that used for slab-milling. While the surface may be badly marked it will yet be almost absolutely true. When the work is set up on edge as shown no trouble is encountered with the chips as is otherwise the case. We are fortunate in finding this piece to be a very easy one to provide jigs for, as it permits itself to be set in almost any position. The method used in Fig. 4 is a good one, and will be found very convenient. The top clamp is removed when the work has to be removed or placed in position. This clamp serves the double purpose of holding the work and of setting it in line, the screw being used to make any allowance for variations in the castings. When this method is chosen the machining of the bottom should be done before the cap bearing is milled as this gives a good solid setting for the latter operation. A great many operations may be accomplished by this latter method which are now milled with plain cutters. The action of the cutter in this operation closely resembles that of the

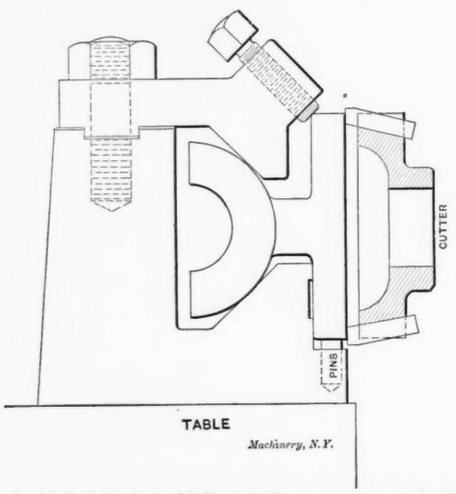


Fig. 4. Another Method of Milling the Lower Surface of the Base.

single pointed tool and has all the advantages that are claimed for this tool, but very few of the disadvantages, and it is a multiple cutter which means greater output.

The milling machine has made great strides in the last twenty years, but we may safely look ahead in the future for the real growth of this method of finishing machine details.

The cuts shown leave considerable to the imagination, as they show but an end view of the work. This is done because the same method may be used to advantage in holding one or a dozen pieces. Elaboration on the above does not seem necessary, since the principle is shown; and since it represents no particular case no figures are given.

The real purpose of the above is to let off a little pressure caused by the editor's comments, and as we milling machine men are very jealous of the machine's record we must always be at hand to contradict any remarks that may serve to cast reflections on its ability to "eat iron" *economically*.

* * *

An illustration of the cost of unwinding red-tape in the conduct of municipal affairs is that of New York City recently in making a small payment. An order directing the payment of five cents to a dealer for making a small blueprint from a tracing passed through the hands of eighteen city officers and cost the city $5, it was estimated, for the transaction. When municipal affairs are conducted on common-sense business principles there will be some hope of cities conducting their public utilities profitably—profitably in the sense of giving better service for less money than is now the rule.

SPRING SCREW THREADING DIES—A CRITICISM OF A CRITICISM.

A. L. VALENTINE.

In the October issue of MACHINERY appeared an article about spring screw threading dies, or rather a criticism upon an article about spring screw threading dies written by a contributor to MACHINERY in the August issue. This criticism led the writer to study more closely the points brought forth in the article written by Mr. Oberg in the August issue, than was done in the first place, and after having made a careful comparison between the different views brought forth in the articles of the two contributors, the writer could not refrain from "butting in," as it occurred to him that the criticism

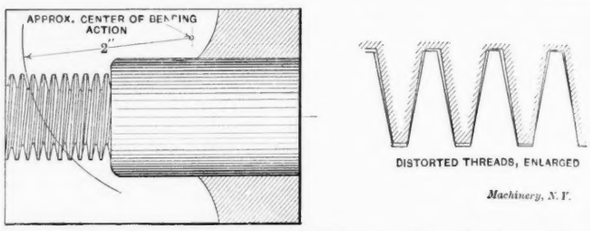


Fig. 1. Spring Screw Die with Special Threads, and Threads Distorted by Common Adjusting Method.

written by Mr. Johnson has several points in itself that should not pass by uncriticised. The need of this will be very apparent to any of the readers if they care to study the subject in question a little deeper, and not consider it from so purely a theoretical or so purely a practical side as was done by the two contributors above mentioned. The subject is one of wide importance and, as Mr. Oberg correctly mentions, there is so little said about these tools in the mechanical periodicals that it would be a pity to lay the subject on the "shelf" so soon. As the writer has had a good deal of experience especially in the making and testing of these tools, a few remarks from him might be of interest as well as of benefit to some of the readers of MACHINERY.

What most prominently attracted the attention of the writer in Mr. Johnson's criticism on Mr. Oberg's article, was the failure of the former to recognize any of the very valuable theoretical facts, set forth in Mr. Oberg's article, as being of any value, when it came to considering the subject from a practical standpoint; furthermore that it would be next to impossible to manufacture these tools as outlined in Mr. Oberg's article, as well on account of the difficulties encountered when making them as the impossibility to make the manufacture of them a financial success. Now, before going any deeper into the subject let me assure the readers of MACHINERY that *nothing was ever practically correct if it was theoretically wrong*, nor has it, in hardly any case, been impossible to devise ways and means of accomplishing anything, if this anything was actually desirable. It may, of course, not be possible without devising something new or something entirely different from old established ways, but is it not rather worth while going to this trouble and be nearly or perfectly correct than to be sure to be wrong, as Mr. Johnson frankly admits in his article that he is, as regards the size and the form of the thread in the spring screw threading dies he is making or in dies made as outlined by him in his article? He is indeed lucky not to have had to make these dies with much sharper angle of thread than 60 degrees, which can be clearly seen from his article and the way he is making his dies, that he has not. For if he had, he would certainly have found Mr. Oberg's way of making them not only practical but he would find it absolutely impossible to produce even a "nearly correct" threaded piece with a spring screw threading die made as outlined by him in his criticism. Let us as-

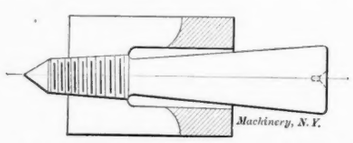


Fig. 2. Spring Screw Die Mounted on Threaded Arbor for Grinding.

sume, for example, that the writer would have made a number of special spring screw threading dies, which the firm he is working for had an order for a short while ago, as outlined by Mr. Johnson. The dies were 2-inch outside diameter and 3½ inches long; the diameter of the piece to be threaded was one inch, the inclusive angle of the thread was 20 degrees; 8 threads per inch, and the depth of thread was 3/16 (see Fig. 1, where the die is shown and where the thread is shown in enlarged scale with the correct angle and with the angle it would have had, had the die been closed to size after having been made as outlined in Mr. Johnson's article). Dies of above description ought to have been hobbed out about 0.015 inch over size, as they were to be used on brass, and in a die with a form of thread with the angle mentioned above it would not be sufficient to close it down to cut to size, it would have to be closed down to cut a certain amount undersize (thus still more in-

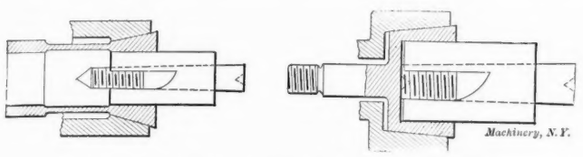


Fig. 3. Grinding the Outside of Spring Screw Dies.

creasing the error in the angle of the thread) to allow the piece threaded with the die to go into the hole tapped out with a tap having the correct angle in the thread, and finally after having adjusted the die down to cut small enough, imagine what a fine fit this threaded piece would have had in the tapped hole. It is admitted that these dies were out of the ordinary, and some one might even say that the rule should be dealt with and not the exception, but the example was given to show that theory will always work and produce correct results where practice fails to do so.

Now let us look into the difficulties encountered when making a spring screw threading die as outlined by Mr. Oberg, and see if these difficulties are unconquerable and if they are real. The worst difficulty seems to be the grinding of the outside of the die true with the thread after hardening. Now if it should be utterly impossible to grind the outside of the die true with the thread after hardening in some cases why should we omit grinding the outside of all dies for this reason? No one can fail to see the advantage, I am sure, of having the part of the die by which it is held (the outside) ground true with the part doing the cutting (the thread). It may be difficult to grind some sizes of dies, but certainly not impossible even under manufacturing conditions as Mr. Johnson thinks it is. The advantages gained would, I think, be fully worth the cost of

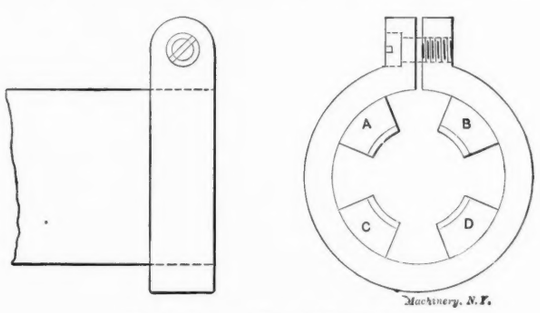


Fig. 4. Common Type of Clamp Collar.

conquering the difficulties encountered, even in grinding one of these "impossible" dies. When grinding the outside of a die true with the thread after hardening, the writer would suggest holding the die, as outlined in Mr. Oberg's article, on a threaded arbor (Fig. 2), but not grinding the whole length of the die at once, as this would be impossible probably in some cases as Mr. Johnson says, but it should be ground for a length corresponding to the length of the thread in the die. The operator will find no difficulty in grinding up on the die for that length as the arbor and the die for that distance are practically one solid piece and are well supported by the centers of the arbor, which of course should not project outside of the die more than necessary. When this is done the die should be taken—with the arbor still in place in the die—and put into a machine equipped with a drawback mechanism and a spring collet or step chuck (Fig. 3). The die is then, of course, held by the outside by the already ground portion of same, and the back can if necessary be supported by the center of the arbor. Anyone making a business of manufacturing spring screw threading dies would find this operation very inexpensive. There are few up-to-date grinding rooms which have not some grinder rigged up with a drawback mechanism and collets used for other purposes; however we will come to the cost later.

The second difficulty encountered by Mr. Johnson in his criticism would be the closing in of the dies in hardening, if made as outlined by Mr. Oberg, viz., to be of the correct size at the point before hardening. Now Mr. Johnson himself in his article tells us of a way to harden these dies and that if the dies are hardened as outlined by him he claims they come out practically straight. His way of hardening is undoubtedly correct, and there is no danger of the prongs of the dies springing or going out of straight if hardened as outlined by him. Why can we not then harden the dies made as outlined by Mr. Oberg in this manner, and save the trouble of having them annealed and rehobbed an unlimited number of times on account of the prongs of the dies being closed in because of *improper* hardening?

Another difficulty was the problem of being able to make the "taper ring" clamp collar remain on the die in an automatic screw machine. Now, in the writer's opinion, there is no clamp collar made as yet that will excel this one, neither the commonly used one (Fig. 4) nor any of the two shown in Mr. Johnson's article. If the difficulty of keeping this "taper ring" clamp collar on the die in an automatic screw machine has been solved in some establishment visited by Mr. Johnson by means

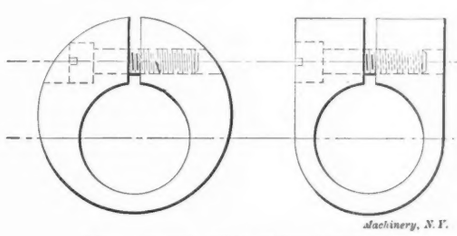


Fig. 5. Special Types of Clamp Collars.

of holding it back on the die with a string that is no reason why this clamp collar is of no use; that merely shows that the establishment in question was lacking in mechanical supervision. While the writer can plainly see the points of superiority of the clamp collar shown to the left in Fig. 5 over the one shown in Fig. 4, he fails to see any superiority of the one shown to the right in Fig. 5. It is claimed in Mr. Johnson's article that both collars shown in Fig. 5 are superior to the one most commonly used (Fig. 4).

Now as to the difficulties encountered in making the business of manufacturing spring screw threading dies financially successful, there is no doubt that the increase in the number of dies sold (on account of the reputation of furnishing the customers with perfect dies) at a smaller profit, will fully outweigh the smaller number of dies sold before at a larger profit. Furthermore, if we look into this extra expense a little more closely, we will find that it is a comparatively small item. A die not ground on the outside after hardening is made from either drawn wire of the correct required size or made from rough stock, which before being made into die blanks had to be turned and ground. A die ground on the outside after hardening is made from rough stock, rough turned and ready for grinding after hardening. Right here we have a saving of either the difference in price of drawn wire and rough stock or the saving of the cost of grinding the soft blanks. If we add to this saving the time saved in not having to be so extremely particular in making the tapped hole run perfectly true with the outside of the die, which we have to be if the die is not to be ground on the outside after hardening, we have quite an item to deduct from our grinding expenses after the dies are hardened. As regards the difference in the expense in making the die taps and hobs the writer can see none. The only increase the writer can see is the expense of making the arbor

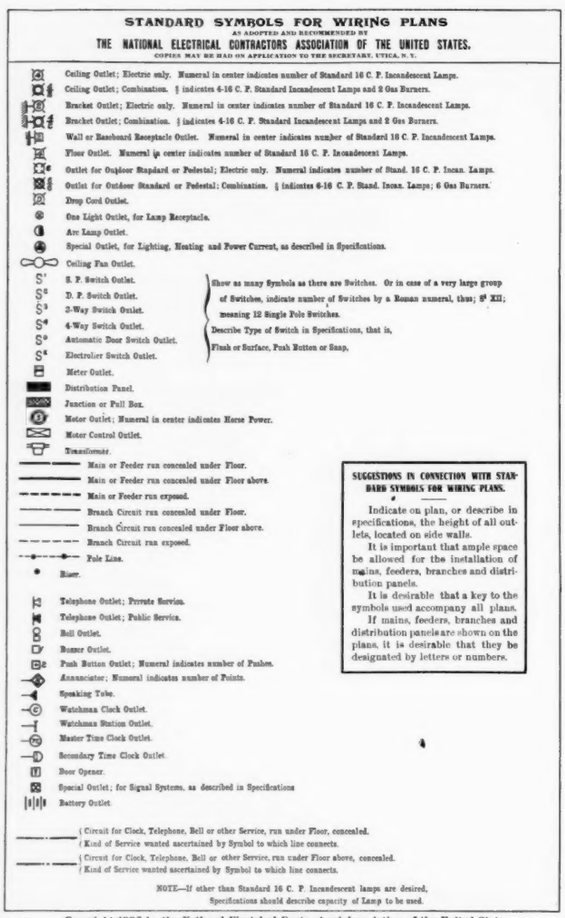
used when grinding the outside of the die, but when considering that this arbor is made exactly the same and at the same time as the hob the expense is reduced to a minimum.

It is to be hoped that the contributor of the article about spring screw threading dies in the August issue of MACHINERY will not think that the writer takes up the defense of some of the theoretical points set forth in his article, on account of thinking him unable or incapable of defending them. It is just because the writer has had the opportunity of using spring screw dies in practice and attained results which were correct in every respect. The means employed were practically the same as outlined in Mr. Oberg's article, and they were not nearly as unfeasible to use, as the latter contributor seemed to think. Just because a new or untried idea may prove itself connected with difficulties, that should be no reason for its immediate repudiation. A thorough investigation should be allowed as to whether the difficulties are real, or if the advantages gained are worth the removal of the obstacles.

* * *

STANDARD SYMBOLS FOR WIRING PLANS.

The accompanying photographic reproduction shows the standard symbols for delineation in wiring plans which were adopted by the National Electrical Contractors' Association at their Cleveland Convention, July, 1906. These symbols were adopted after a year's careful consideration and conference with leading engineers, architects, professors, government



STANDARD SYMBOLS FOR WIRING PLANS
AS ADOPTED AND RECOMMENDED BY
THE NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION OF THE UNITED STATES.
COPIES MAY BE HAD ON APPLICATION TO THE SECRETARY, UTICA, N. Y.

Ceiling Outlet; Electric only. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Ceiling Outlet; Combination. ½ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.
Bracket Outlet; Electric only. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Bracket Outlet; Combination. ½ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.
Wall or Baseboard Receptacle Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Floor Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.
Outlet for Outdoor Standard or Pedestal; Electric only. Numeral indicates number of Stand. 16 C. P. Incan. Lamps.
Outlet for Outdoor Standard or Pedestal; Combination. ½ indicates 4-16 C. P. Stand. Incan. Lamps; 6 Gas Burners.
Drop Cord Outlet.
One Light Outlet, for Lamp Receptacle.
Arc Lamp Outlet.
Special Outlet, for Lighting, Heating and Power Current, as described in Specifications.
Ceiling Fan Outlet.
S' S. P. Switch Outlet.
S² D. P. Switch Outlet.
S³ 3-Way Switch Outlet.
S⁴ 4-Way Switch Outlet.
S^D Automatic Door Switch Outlet.
S^E Electrolier Switch Outlet.
Show as many Symbols as there are Switches. Or in case of a very large group of Switches, indicate number of Switches by a Roman numeral, thus; S^X XII; meaning 12 Single Pole Switches.
Describe Type of Switch in Specifications, that is, Flush or Surface, Push Button or Snap.
Meter Outlet.
Distribution Panel.
Junction or Pull Box.
Motor Outlet; Numeral in center indicates Horse Power.
Motor Control Outlet.
Transformer.
Main or Feeder run concealed under Floor.
Main or Feeder run concealed under Floor above.
Main or Feeder run exposed.
Branch Circuit run concealed under Floor.
Branch Circuit run concealed under Floor above.
Branch Circuit run exposed.
Pole Line.
Riser.
Telephone Outlet; Private Service.
Telephone Outlet; Public Service.
Bell Outlet.
Buzzer Outlet.
Push Button Outlet; Numeral indicates number of Pushes.
Annunciator; Numeral indicates number of Points.
Speaking Tube.
Watchman Clock Outlet.
Watchman Station Outlet.
Master Time Clock Outlet.
Secondary Time Clock Outlet.
Door Opener.
Special Outlet; for Signal Systems, as described in Specifications.
Battery Outlet.
Circuit for Clock, Telephone, Bell or other Service, run under Floor, concealed. Kind of Service wanted ascertained by Symbol to which line connects.
Circuit for Clock, Telephone, Bell or other Service, run under Floor above, concealed. Kind of Service wanted ascertained by Symbol to which line connects.
NOTE—If other than Standard 16 C. P. Incandescent lamps are desired, Specifications should describe capacity of Lamp to be used.

SUGGESTIONS IN CONNECTION WITH STANDARD SYMBOLS FOR WIRING PLANS.

Indicate on plan, or describe in specifications, the height of all outlets, located on side walls.

It is important that ample space be allowed for the installation of mains, feeders, branches and distribution panels.

It is desirable that a key to the symbols used accompany all plans.

If mains, feeders, branches and distribution panels are shown on the plans, it is desirable that they be designated by letters or numbers.

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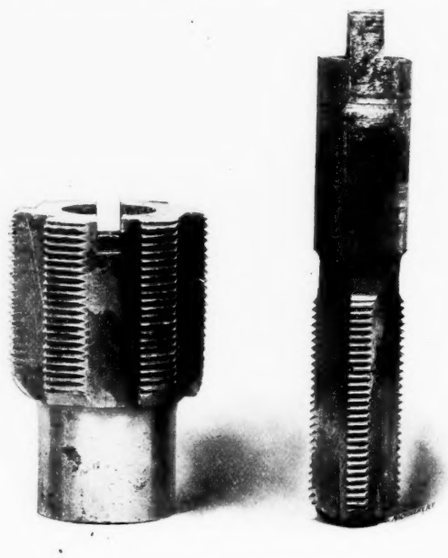
employes, editors of technical publications, etc. It is believed by the committee that they represent in convenient and readily recognized form the parts designated. The symbols and explanation shown in the reproduction are printed on cardboard, 10½ x 16 inches, and copies may be obtained upon request from the secretary, Mr. W. H. Morton, 94 Genesee St., Utica, N. Y.

* * *

Don't take a finishing cut on a broad surface of cast iron without first filing the scale on the front end all away as far down as the tool goes.

TWO TAPS WITH A GOOD ENDURANCE RECORD.

The accompanying halftone shows two taps used in the works of the Reo Motor Car Co., Lansing, Mich., which have a good record for endurance, each having tapped 10,000 holes ¾-inch deep. The larger tap is 2¼ inches diameter and the other 1 inch, and both are of the same pitch, 12 threads per inch. The length of holes tapped equals 7,500 lineal inches, or 625 feet of cast iron, and the taps are still in fairly good shape. The long endurance of these taps is attributed to the method of tempering developed by Mr. J. F. Sallows, foreman



Taps with Good Endurance Record.

blacksmith of the Reo Motor Car Co. The taps are soft enough to be machined anywhere except the teeth, and the same method is employed by him on all similar tools, only the cutting parts being made hard. Mr. Sallows' method is to temper at a low heat in cold salt water and sperm oil. We understand that his method of tempering will be fully explained in detail in a new book to be published soon by the Technical Press, of Brattleboro, Vt.

* * *

OCCASIONAL ANNEALING OF MACHINE PARTS TO PREVENT BREAKAGE.

On many machines the writer has noticed during his experience, there are frequent breakages of particular parts. It is almost periodically expected that certain parts will last just so long before they crack. In some cases this, of course, is unavoidable and occurs through excessive work on a particular part, which wears it rapidly, but where a piece breaks often with no great amount of wear on it we must look for another cause, and this will almost invariably be due to crystallization of the granular structure of the material. This crystallization of steel or iron will occur through frequent shocks, and any piece which is subjected to vibration will quickly become crystallized, and then the strain required to break the part is little greater than that required to break a section of glass of about the same dimensions.

To prevent the breakages of such parts, an excellent plan which has been found to give unfailing results is to remove from the machine such part and heat same to about 900 degrees to 1,200 degrees F. and allow same to cool in lime or in the furnace where it is heated. This is simply an annealing treatment and allows the structure of the material to assume its original condition as before being subjected to the disturbing influence.

This method has saved a considerable amount of repairing and replacement on such machines as engines, planers, trip hammers, and other machine tools where there is any shock or vibration.

VIBRATION.

LETTERS UPON PRACTICAL SUBJECTS.

SIMPLE METHOD OF PROVING MULTIPLICATION.

In the August issue of MACHINERY there appeared an article which interested me on proving multiplication and addition by casting out the nines. For simple multiplication the operation may be simplified somewhat. Example as follows:

```
  31416
   7854
 ------
 125664
 157080
 251328
 219912
 ------
246741264
```

Add the digits in the multiplicand, $3+1+4+1+6=15$, and $5+1=6$. Add the digits in the multiplier, $7+8+5+4=24$, and $2+4=6$. 6 times $6=36$ and $6+3=9$. Add the digits in the product, $2+4+6+7+4+1+2+6+4=36$, and $6+3=9$. That is, add the digits in the multiplicand and multiplier until we obtain a result of one figure, multiply these together and add again until the result is expressed in one figure. The sum of the digits in the product, proceeding in the same way, should be the same.

This method is a very rapid one, as even a long multiplication may be quickly checked by a mental calculation. However, it should be noted that neither this, nor casting out the nines, is an absolute proof. A failure of either of these tests shows the example to be wrong, but if the digits anywhere are simply interchanged the answer may be incorrect and yet according to the above test be right. This, however, would seldom happen.

KENNETH G. SMITH.

Wellsville, N. Y.

A GRINDING FIXTURE AND ITS WORK.

The line cuts and halftone illustrate a very fast and successful little fixture for grinding a radius on a segment gear blank. The work is previously finished to the dimensions given in Fig. 1, the dotted lines showing the stock left for

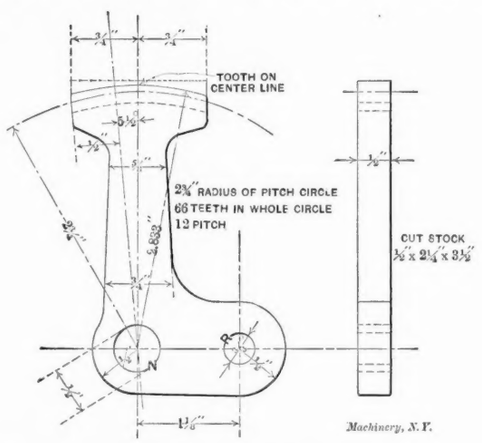


Fig. 1. Gear Segment to be Ground.

grinding the radius of the outside diameter of the segment blank. The grinding was done on a No. 3 Universal Landis grinding machine, the machine, fixture and a pile of rough and finished work being illustrated in Fig. 2. An assembled view of the fixture is illustrated in the drawing Fig. 3.

The fixture comprises a base suitably arranged for clamping to the swivel table of the grinding machine; this base carries at the height of the center of the grinding wheel a pin or fulcrum on which is pivoted a work-carrying arm which may be seen in Fig. 3. This arm is provided with a slot of a suitable width to receive the work, which is first slipped on to a projection of the fulcrum and then swung down into the slot where it is clamped by means of a thumbscrew, a locating pin being rightly situated to properly locate the work. Upon the fulcrum is also pivoted a gage, which is set so that its point will indicate when the work is ground to the right radius.

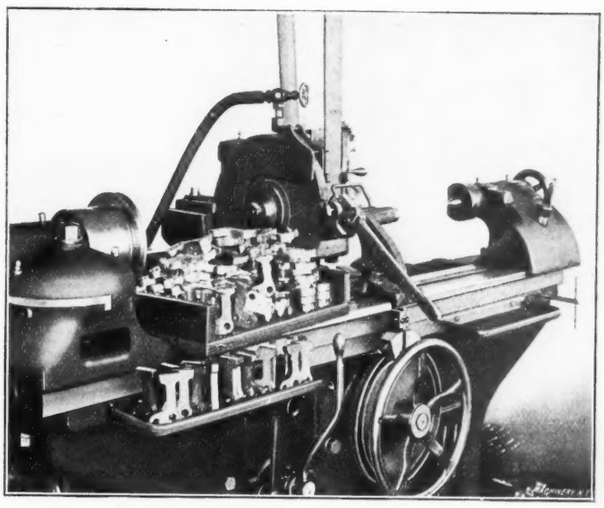


Fig. 2. The Fixture, Work and Grinding Machine.

The work is ground, without traverse of the grinder, by swinging it slowly up past the face of the wheel, which is of such a width as to fully cover the work. Three cuts are necessary to bring it down to size, the last being a light or

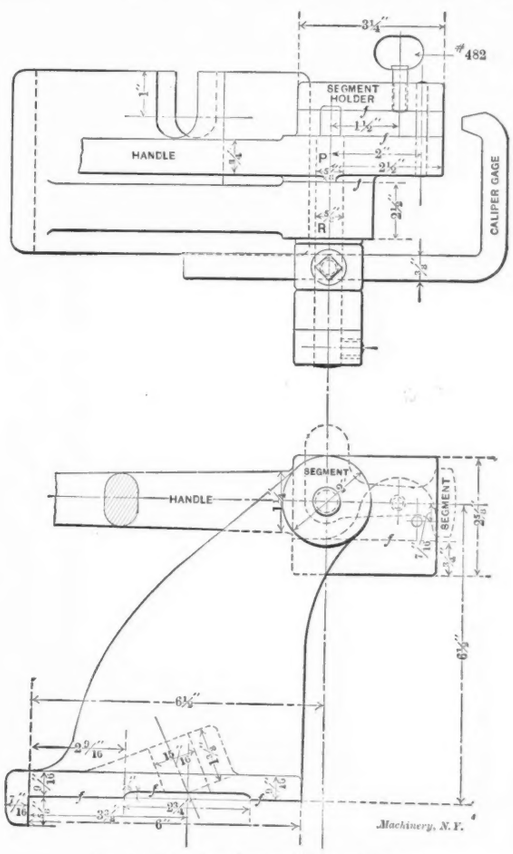


Fig. 3. Side Elevation and Plan of Fixture.

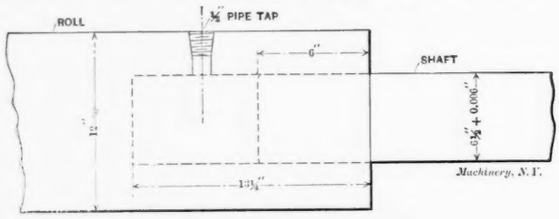
finishing cut. The material of these pieces was soft steel, and they were finished in this way at the rate of 40 per hour, the wheel showing average reduction for wear of about 0.001 inch for five pieces. Some of these were finished as fast as one in 38 seconds.

H. F. NOYES.

Waynesboro, Pa.

THE USEFULNESS OF HYDRAULIC PRESSURE.

The following occasion sets forth one of the many uses to which hydraulic pressure may be put. The top roll of our 10-foot plate bending rolls snapped off at the point where the driving shaft joins on during the process of rolling ¾-inch plate. The roll was then bored out to 6½ inches diameter for a distance of 13¼ inches. The corresponding end of the shaft was turned to a diameter of 6½ + 0.006 inch, as a shrinking fit had to be resorted to, there being no access to a suitable hydraulic press. The end of the roll was subjected to the proper degree of heat, and the shaft started to be put in place. Unfortunately, the rope loop supporting the shaft happened to exert a twisting strain on the shaft, causing it to twist the distance of half the width of the keyway. The few moments occupied in endeavoring to readjust allowed the roll to cool sufficiently to make it impossible to force in the shaft any further. The problem was then how to remove the



The Usefulness of Hydraulic Pressure.

shaft, as it had been inserted but six inches. Hydraulic pressure suggested itself, so the keyway was packed with lead very tightly; ½-inch pipe tap was tapped into the roll as shown in the cut; the hydraulic pump set to work, and with a pressure of 3,000 pounds per square inch the shaft was forced out. This instance suggests a novel use for such pressure, and one, which in our case, saved much valuable time and expense.

Springfield, O. CALVIN B. ROSS.

TO FIND THE RADIUS OF AN ARC WHEN THE LENGTH OF THE CHORD AND THE HEIGHT OF THE ARC ARE GIVEN.

I show herewith a method of obtaining the radius of a circle when the height of an arc and the length of its chord are given, thinking that there may be some of your readers who would like to put the formula in their note books. As shown in the sketch

A = apothegm of chord,
H = height of chord.
L = length of chord,
R = radius of arc.

$$\text{Then } R = \frac{\frac{\left(\frac{L}{2}\right)^2}{H} + H}{2}$$

This formula is derived as follows:

$$R^2 = \left(\frac{L}{2}\right)^2 + A^2 \qquad (1)$$

since R, A, and $\frac{L}{2}$ form three sides of a right angle triangle.

It is also plain that

$$R = A + H. \qquad (2)$$

Squaring this we have:

$$R^2 = A^2 + 2AH + H^2 \qquad (3)$$

Combining 1 and 3 we have:

$$\left(\frac{L}{2}\right)^2 + A^2 = A^2 + 2AH + H^2$$

Simplifying and transposing

$$2AH = \left(\frac{L}{2}\right)^2 - H^2$$

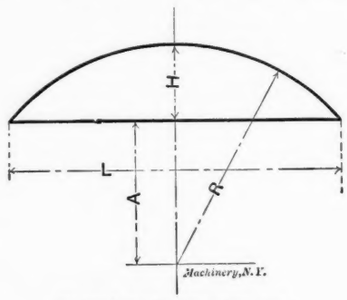
$$A = \frac{\left(\frac{L}{2}\right)^2 - H^2}{2H}$$

Substituting this value for A in equation 2 we have:

$$R = \frac{\left(\frac{L}{2}\right)^2 - H^2}{2H} + H$$

which simplified gives the formula proposed above.

When the height and radius are given this formula may be



To Find the Radius of an Arc.

rearranged to be used in finding the length of the chord, thus:

$$L = 2\sqrt{H(2R - H)}.$$

Find, for example, the radius when the height of the chord is ⅜ inch and the length of the chord is 1½ inch. Substituting these quantities in the formula given, and solving, we have:

$$R = \frac{\frac{\left(\frac{L}{2}\right)^2}{H} + H}{2} = \frac{\frac{0.75^2}{0.375} + 0.375}{2} =$$

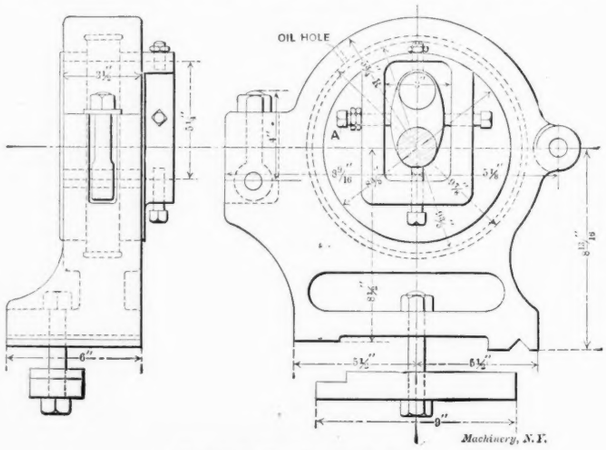
$$\frac{\frac{0.5625}{0.375} + 0.375}{2} = \frac{1.5 + 0.375}{2} = 0.9375 = R$$

The radius is therefore 0.9375 inch, or 15/16 inch.

Torrington, Conn. E. C. FALK.

A CRANKPIN TURNING DEVICE.

The device shown in the accompanying cut was designed to turn the crankpins of small crankshafts so that they would be in line. The crankshaft for which this device was designed was of the drop-forged type, 2½ inches throw, with webs of the shape shown in the cut. The distance between the bearings was from 3 to 4 feet, so that in turning the



Device for Turning Crankpins.

pins, the shaft would spring, consequently the pins would be out of line. After many complaints from the erecting floor, the drawing room "got busy," with this device as the result. I saw it working, and in my judgment it did "the trick." The idea is an old one, as I have seen it before in a more complicated form, but owing to its simplicity of construction and manipulation I offer it to the readers of MACHINERY, some of whom may have the same difficulties to overcome.

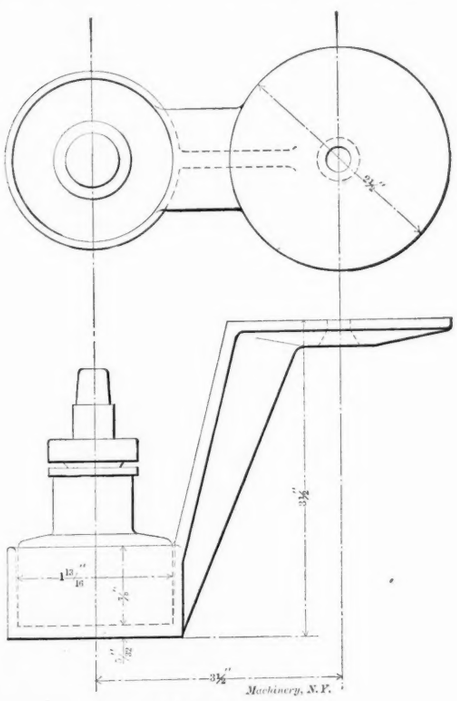
The device consists of two parts, a steady-rest, and a piece which I will call a chuck. The steady-rest is fitted to a lathe and bored out in place. The chuck is turned to a running fit in the rest. Before the shaft is put in the lathe, it is lined up on the planer and a light cut taken off the four sides of the web, just enough to make a flat surface for the setscrews to bear against. Another reason, in fact the most important one, will be explained farther on. The shaft is now placed in the lathe on centers which give it the desired throw. The pin is set central by means of the setscrews shown. When this has been done, the setscrew at the top is locked by means of the check-nut. The two check-nuts on the setscrew *A* are screwed against the side of the chuck. As it is necessary to move this screw when moving the crankshaft, two check-nuts are required; the first to indicate the position of the screw and the second to lock the first. The pin is now ready to be turned. After one pin has been turned, the setscrews on the bottom and sides are loosened and the device moved to the next pin. The top setscrew not having been moved, we have that point. Setscrew *A* is now screwed into its original position, made possible by means of the check-nuts. The other two setscrews force the web against these two fixed points and the job is ready for turning the other pin.

As all the flat bearing surfaces are in line and the setscrews occupy the same position after each setting, it will be seen that there is small possibility for the pins not coming in line. In taking the shaft out of the lathe, nothing has to be changed, as the hole in the chuck is large enough to allow the webs to pass through.

H. M. C.

CONVENIENT INK BOTTLE HOLDER.

I noticed in the June issue of MACHINERY a neat arrangement for holding the ink bottle securely and "right side up." This matter has been a great source of trouble with most draftsmen and many schemes have been used. I always kept the bottle I was using in a drawer attached to the table, and found that a very effective method of overcoming the difficulty. We now have in our drawing room a bracket holder,



Ink Bottle Holder.

as shown in the cut. This holder is attached to the under side of the table by a single screw so that it may be swung around out of the way. This arrangement obviates the necessity of hauling everything around to find the missing bottle as it is always in the right place; it also eliminates the liability of blotting the work when filling the pen. The danger of spilling the ink is also reduced to a minimum. It seems that all the bad points of all other methods are overcome in the holder shown herewith.

Mr. Moody's arrangement is good, but the idea of using an ink bottle as a paper weight does not appeal to me as being satisfactory or advisable. My idea is that the drawing board is made to hold drawings, and drawings only, the fewer the better.

JOHN EDGAR.

Hyde Park, Mass.

SINGLE-STROKE AND CONTINUOUS-RINGING BELL.

Referring to question 22 in "How and Why," September issue of MACHINERY, I give herewith a sketch of a single-stroke bell, Fig. 1; also a continuous-ringing bell, Fig. 2.

When the button in Fig. 1 is pressed, the plunger *P* will run up into the solenoid and strike the bell one stroke. In

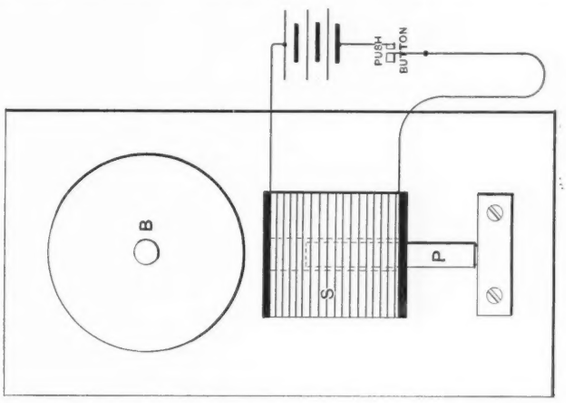


Fig. 1. Single-stroke Bell. Read Cut with Plunger Vertical.

the off position the plunger rests on a small wooden block. This device was installed at the Union Station, Minneapolis, by myself and works satisfactorily.

The continuous-ringing bell is constructed so that wire *a* from the right-hand solenoid crosses to the left-hand contact piece *b*, and the wire *c* from the left-hand solenoid crosses to the right-hand contact piece *d*. The switch is pivoted at *P* and when the plunger is in the position shown it is attracted toward the right-hand end. When it moves to the right-hand it touches the contact *d* and closes the circuit for the left solenoid and opens the circuit for the right solenoid. Then the left solenoid drives the plunger through to the left and

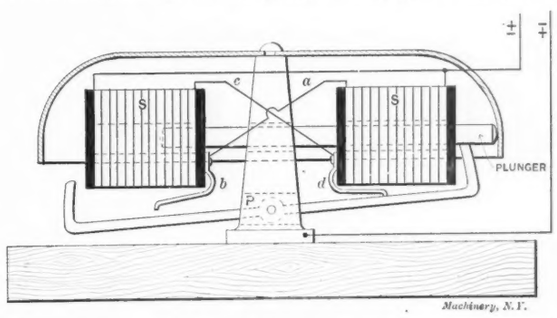


Fig. 2. Continuous-ringing Bell.

strikes the bell. The plunger is then an electromagnet because of the action of the coil and draws the left end of the switch toward it, the switch being made of iron. The switch then touches the left contact piece and closes the circuit for the right-hand coil and opens the circuit for the left-hand coil. The plunger then flies to the right and strikes the bell. The switch is hung so as to be slightly unbalanced, thereby securing contact to one of the coils and enabling the plunger to start.

JOSEPH CHAMBERS.

Tacoma, Wash.

THE APPRENTICESHIP QUESTION.

The article on "The Apprenticeship Question" in the August issue was a very timely one, it seems to me, and came from a man who well understands the question, judging from

what I have read of his writings, but it seems to me there are some points that have been overlooked in his articles which would be helpful to all concerned. While my judgment may not be very accurate, it seems to me that many apprentices are not receiving the attention they are entitled to. Most boys, when they start to learn the machinist's trade, are ambitious to learn. Why is it, then, that after ten or twelve months' service in a shop this spirit is lacking? The boy is listless and has not the enthusiasm that he had at the start. What is the cause?

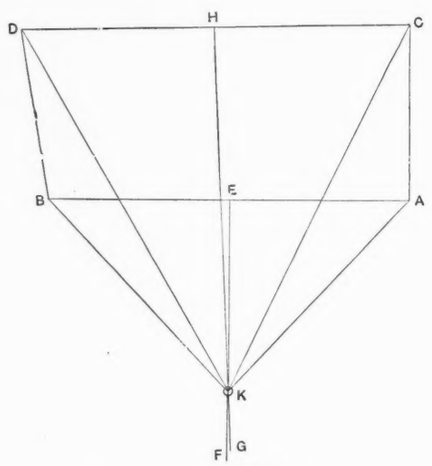
Just as long as apprentices are employed in shops there will be some who come in who are not adapted to the trade. The management is not always to blame for this, because there is no way of determining beforehand if the boy is mechanically-inclined. But after ten or twelve months' service it should be possible to judge very accurately as to fitness for the work and during the probationary service the management should not be idle in their attention to the boy. If one wants results from a boy (or from a man, for that matter) he must be kept interested in his work. When put to a machine he must be shown explicitly how to operate it and the best way of performing the work. He must be given an opportunity to form an idea of what is required and it must be impressed upon his mind that it is important that he is doing all his work right. He must not be permitted to develop a slovenly manner of work. If his interest is kept up he will turn out far more work and it will be of a higher class comparatively. He must be given as wide a range of work as the shop permits, and the expectancy of better work will prove a strong incentive to good results.

A great many boys commence to complain of their pay after six or eight months' service unless there is a hard and fast schedule. As a preventative of this, it is advisable that time is taken to show the apprentice the cost of some of his work, and in many cases this is sufficient to cure the greatest "kicker," because it is well known that the ones who usually do the most "kicking" are the ones who perform the least work. If the apprentice had an idea of what he is worth and knew what the machine he is working with is worth per hour, including his services, he would be able to figure his output. This would give him the means to realize whether he is paid too low compared with his more skilled companions in the shop. The ability of estimating the cost of machine work is one that is very rarely ever taught an apprentice, but it is of the greatest value. It is gratifying to find that many of our large concerns are awakening to this fact and are establishing schools of instruction. Of course it takes time and trouble to show the apprentice the how and why, but it is better to spend the time thus than to spend it trying to catch him "playing possum." When I hear of an official complaining of his apprentices as being "no good," it lessens my respect for him as a shop manager. He is the man who is at least partly responsible for their failure as mechanics because of his lack of attention and interest in their development. It would be much better for him to have them brought up to be first-class mechanics and to give some of his time in accomplishing this than it is for him to hire any man that comes along to do his best work and afterward find that many a man whom he has hired is no better than those he has. The former he will pay high wages because he does not know them, but his own boys cannot get the same pay because, as he thinks, he knows them. This inconsistency is hard to understand. If the men in charge would spend more time and more interest in developing their own apprentices, teach them how to estimate, give them opportunities to gather information in mathematics and mechanical drawing, it would be found that it would be for the mutual benefit of all concerned. A few hours a week spent this way would cost the management very much less than an hour or two a day spent by every apprentice worrying over a blueprint, only to still get mixed up in the end and spoil the job. The foreman cannot be everywhere at once, although I have seen a few that were marvels in the latter particular, if you were not looking for them. A good idea would be for a manager to take a few trade papers and when through with them give them to the apprentices instead of throwing them in the waste basket. An apprentice should be accustomed to read things pertaining to his trade. If the boy will read trade papers at noon instead of dime novels, the man will be able to take a responsible place in time of need. It may be that some firms have the best way of doing things, as far as they can see, but it may be that upon considering the matter more closely things may look different. When the apprentice is doing well he should be encouraged as readily as he is blamed when he is doing wrong. If some one would try some of the suggestions put forth, it would be for the benefit of us all, if he would let us know of his experience. E. T. STRONG.

Urbana, Ill.

OLD EUCLID DISPROVED AT LAST.

If the editor would have permitted me I should have entitled this "Startling Revelation in the Science of Mathematics," and should have had the heading printed with 3-inch-high letters, because, in fact, my discovery is of so unique a character as to put me in a class with Newton and Pascal. For more than 3,000 years we have considered the statements of Euclid as unquestionable, but at last it has been possible by a simple method to disprove the truth of the very foundation of geometry! Draw a straight line, *AB*, as shown in the cut. From *A* draw a line *AC* at right angles to *AB*. From *B* draw a line *BD* at an angle larger than 90 degrees to *AB*. Make *BD* equal to *AC*. Draw *CD*. Divide *AB* in two equal



Old Euclid Disproved.

parts at *E*. Draw *EF* at right angles to *AB*. Divide *CD* in two equal parts at *H* and draw *HG* at right angles to *CD*. *EF* and *HG* intersect one another at *K*. Draw *AK*, *BK*, *CK*, and *DK*. We are now ready for the startling revelation. *AEK* and *BEK* are right-angle triangles. *BE* equals *AE*, *EK* is mutual for both triangles, consequently the triangles are equal and the angle *EAK* equals *EBK*, and the line *AK* is equal to *BK*. The triangles *CKH* and *DKH* are also equal, being right-angle triangles, with the side *DH* equal to *CH* and the side *HK* mutual to both. The side *CK* is then equal to *DK*. If we now consider the triangles *ACK* and *BDK* we know that *AK* equals *BK*, *CK* equals *DK*, and *BD* was originally made equal to *AC*. Consequently these triangles are equal, and the angle *CAK* equals the angle *DBK*. If from these angles we subtract the angles *EAK* and *EBK* respectively, which we have found to be alike, the remaining angle *CAB* is equal to *DBA*. The angle *CAB* is a right angle according to our construction. The angle *DBA* is larger than a right angle. We have proven them to be alike by means of the fundamental propositions of geometry. Hence Euclid must be wrong in the very first principles upon which he founds his geometrical propositions.

It may be that the editor will not consider my discovery epochal, and that it is the reason for his declining the 3-inch high letters for a heading, but even if his check should fail, I am convinced that my discovery is the very greatest in the field of science during the present year, and I expect to receive the Nobel prize for scientific research, which would

amply compensate me for my disappointment in regard to the 3-inch high letters for the heading, upon which my heart was particularly set. R. S.

COMMENTS ON "TO INCREASE THE WORKING LENGTH OF COIL SPRINGS."

Referring to the article entitled "To Increase the Working Length of Coil Springs" in the August issue of MACHINERY, the writer wishes to call attention to some points not mentioned which will materially alter the case. In the two cuts shown in the article the working length of the open-wound spring appears greater than that of the close-wound spring. However, the distance a spring will safely extend is determined by the number of acting coils it contains, and not by the number of inches of working length. Each of the springs shown has about nine acting coils and therefore both the springs will be about equivalent in their action. Now, if the close-wound spring were made with one-half of each end coil bent up for hooks instead of using the tapered ends and forged hooks, several more acting coils would be added to each end of the spring without increasing the length over all, and consequently the close-wound spring could be made shorter for a given working length than could the open-wound spring with links. The cut shows a spring made in this manner. This is the style of hooks generally used on extension springs, being easier and cheaper to make and in 99 cases out of 100 gives fully as good service.

Increasing the Working Length of Springs.

There are, however, two important advantages in the open-wound spring with links, which are not referred to in the article mentioned; first, the impossibility of injuring such a spring by any reasonable overload. The spring simply compresses under overload until the coils touch and then acts as a solid connecting link; second, the fact that in the case of the coil part breaking the links act as a safety device maintaining the connection between the parts to which the spring is attached. For instance, when used as a trace spring to relieve the horse of the jars caused by the unevenness of the road, if the coil should break, the trace is still attached to the whiffletree and no runaway or accident follows.

F. E. W.

METHOD OF DIVIDING FRACTIONS BY TWO.

Under the heading, "Method of Dividing Fractions by Two," an article was published in the August issue, evidently with the intention of placing on exhibition the longest known method for cutting a fraction "through the middle." Mr. Lang attacks a fraction in about the same way as a farmer would cut off a piece of cold-rolled shafting, commencing with a file, then using a cold chisel for a while, after which he might take turns with the pipe cutter and milling machine, and if he did not happen to think of the emery grinder he would undoubtedly finish with the hacksaw, the tool which should have been used at the start. It may be that the other tools might do the job, but nobody is likely to care to wait for the result obtained in that way.

A man who cannot set his dividers to one-half the given fraction of the dimension for the diameter without looking up his table of decimal equivalents first should not expect pay for overtime. Although there are quite a few mechanics (?) who have passed through their apprenticeship and are still deficient in fractions, I do not believe that the given method will be of any assistance to any of them.

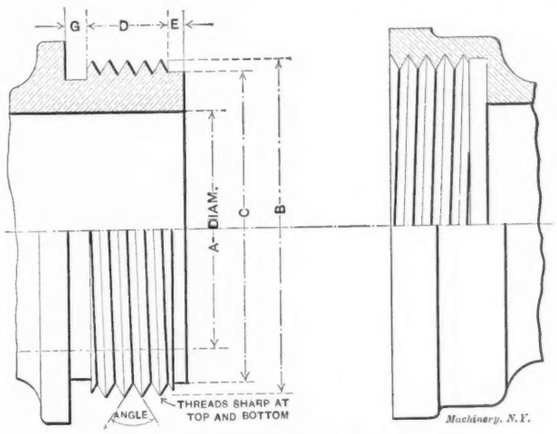
The quickest way is always the best. Try this: taking for example, $11/64 \div 2 = 11/64 \times \frac{1}{2} = 11/128$; cutting this short for convenience, we say $64 \times 2 = 128$, and using the same numerator we have 11/128. This principle is equally applicable to the division of fractions by any number. For instance, $7/9 \div 2 = 7/9 \times 2 = 7/18$, and by Mr. Lang's method we experience some difficulty in finding the decimal equivalents of 7/9 or 35/9, and even if such tables were available, the simple rule that you learned when you were nine years old would give the correct result quicker than you can find it in the table. Just add enough ciphers to give the proper number of places to the numerator and divide by the denominator; thus, $7/9 = 7.0000 \div 9 = 0.7777$, which is sufficiently accurate for a measurement with micrometers; by the same formula 55/64 becomes $55.000000 \div 64 = 0.859375$. I do not want to belittle the value of tables and note books; some of the data sheets are worth many times the price of the paper, but I am surprised to see a good mechanic waste his time in the way mentioned. EUGENE PIERCE.

Ilion, N. Y.

[We are not at all sure that Mr. Pierce can carry out his lengthy divisions, particularly when halving 64ths any quicker than Mr. Lang carries out his simple multiplication and looks in his table, but the criticism is so unique in its certainty and in its comparisons that we felt under obligation to publish the matter and permit our readers to judge for themselves. To find the decimal equivalent at once, and divide it by two, seems the simplest way in regards to 64ths. In regards to 32ds, 16ths, etc., there seems to be no need of either multiplications, nor lengthy divisions, and Mr. Pierce is, of course, applying the correct principle for such cases, if he simply multiplies his denominator by two.—Editor.]

STANDARD HOSE COUPLING FOR NAVAL CONSTRUCTION.

There was published, in the July issue, Standard Hose Couplings, as agreed upon by the National Fire Protection Association. This standard differs somewhat from the one used in naval practice. The following table of dimensions



STANDARD HOSE FOR NAVAL CONSTRUCTION.

A	*B*	*C*	*D*	*E*	*G*	Angle.	No. of Threads per inch.
$\frac{1}{2}$	$1\frac{1}{16}$	Bottom of Thread.	$\frac{5}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	60° 0′	14
$\frac{25}{32}$	$1\frac{9}{32}$	Bottom of Thread.	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{8}$	60° 0″	$11\frac{1}{2}$
1	$1\frac{5}{16}$	Bottom of Thread.	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{8}$	60° 0″	$11\frac{1}{2}$
$1\frac{1}{32}$	$2\frac{3}{32}$	$1\frac{31}{32}$	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{8}$	77° 20″	10
2	$2\frac{13}{32}$	$2\frac{9}{32}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$2\frac{1}{32}$	$3\frac{11}{32}$	$3\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
3	$3\frac{13}{16}$	$3\frac{19}{32}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$3\frac{1}{2}$	$4\frac{5}{16}$	$4\frac{3}{32}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
4	$4\frac{7}{8}$	$4\frac{21}{32}$	1	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$4\frac{1}{2}$	$5\frac{9}{16}$	$5\frac{5}{32}$	1	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
5	$5\frac{1}{8}$	$5\frac{21}{32}$	$1\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$5\frac{1}{2}$	$6\frac{13}{16}$	$6\frac{5}{32}$	$1\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18′	7
6	$6\frac{1}{8}$	$6\frac{21}{32}$	$1\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$6\frac{1}{2}$	$7\frac{13}{16}$	$7\frac{5}{32}$	$1\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
7	$7\frac{1}{8}$	$7\frac{21}{32}$	$1\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7
$7\frac{1}{2}$	$8\frac{13}{16}$	$8\frac{5}{32}$	$1\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{8}$	66° 18″	7

complies with the naval specifications for hose threads and may be of some value to the subscribers employed in marine works which are at times engaged in naval construction.

Brooklyn, N. Y. A. H. NOURSE.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

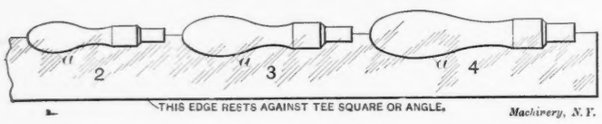
A HANDY SCREWDRIVER.

The machinist many times wants a small screwdriver, and the kind used by watchmakers do not have the "grip" needed. I made one like the cut from 3-32-inch steel wire, about 4 inches long, and it has seen many years' service and is

good yet. The part *A* is made of brass ½ inch in diameter, 3-16 inch thick, and knurled on the edge. The cup piece *B* is also of brass, dished as shown. F. H. J.

TEMPLATE FOR DRAWING MACHINE HANDLES.

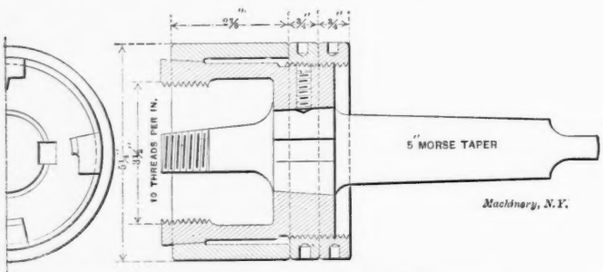
The drawing of machine handles may be facilitated very much by the aid of a celluloid template. Two templates are made, one containing profiles of the four smaller sizes, and the other containing the three larger sizes. If there is a forming tool for each size it is an easy matter to make the



templates and thereby have the drawings the same outline as the formers. They not only facilitate drawing, but also allow of a proper section for each requirement. The outline, *a*, of the lower half of the handles is scratched on the templates and is filled in with black wax. WINAMAC.

LARGE SPRING SCREW THREADING DIES.

Thinking that some of the readers of MACHINERY may be interested in a large spring screw die of which type I have designed several, the one in the accompanying cut being the largest, I hereby submit it for their approval. This die was made to use in a limited space, the collar and the check



nuts running within 1-16 inch of a projecting flange, it being impossible to use any other type of die. These dies work in a very satisfactory manner and are used on brass. They do not need a lengthy description, as the cut will explain their operation and construction satisfactorily.

Boston, Mass. LOUIS F. LANG.

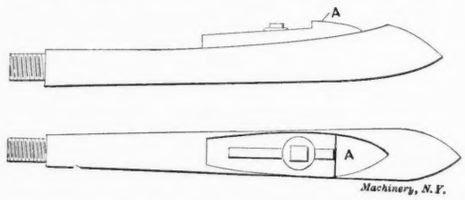
HOW TO PREVENT A UNIVERSAL CHUCK BECOMING CLOGGED WITH CHIPS.

Here is a way which I have used to prevent a universal chuck becoming clogged up with chips. Take apart the chuck and in the outer shell lay out three holes ⅝ inch diameter for a 6-inch chuck, midway between jaw race and pinion wrench holes, where it will weaken the shell the least, and a distance in from outer face of chuck so that the point of the drill will break through about 1-16 inch from the inner face. The holes should be drilled ½ inch further after the point breaks through, cutting a groove in the inner face with the lip of the drill. A ⅝-inch hole is about the right size for a 6-inch chuck; smaller or larger chucks would, of course, need smaller or larger holes in proportion. Use dry graphite instead of oil in the chuck. A chuck with holes drilled as above is specially good for turning composition metal at high speed, and will clear chips almost as fast as they get in.

South Boston, Mass. F. B. POOLE.

A PIPE PULLER.

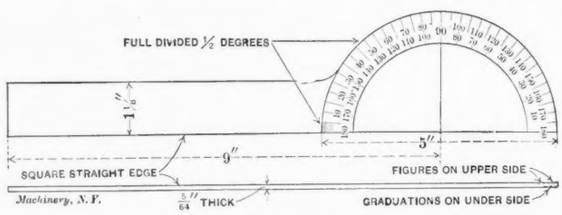
Did you ever have a pipe to pull out of the ground, that you could not get hold of? If so, the device shown in the cut will be of value in many cases. Of course it has to be made to suit the size of pipe inside. No explanation is necessary, as the cut shows the device very plainly. The tool is secured



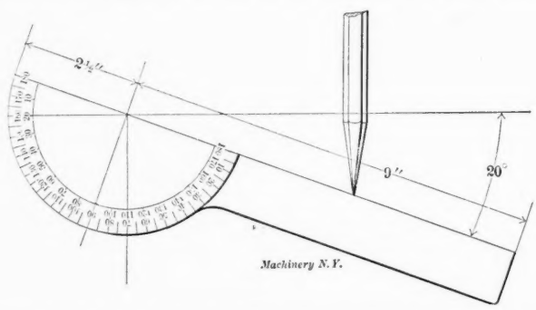
into a piece of pipe of proper length, and pushed down in the hole until the end enters the hole in the pipe to be pulled out. When the pull is made, the part *A* slips down, wedging in the pipe, and pulls the pipe out. F. H. J.

DRAFTSMAN'S IMPROVED PROTRACTOR.

I enclose a sketch of a protractor which was designed to meet the demands for one that would be better suited for dividing a circle than can be done with those now on the market. It is not intended to do the work that the B. & S. protractor can do, but principally to facilitate the plotting of angles for cams and cam charts. In laying out angles of this



kind or in general work with the ordinary protractor it is necessary first to point off the angle, then to remove the protractor and draw the line through the point. This protractor, having an extended arm, enables the operation to be done with the one setting. A number of draftsmen have shown their desire to obtain one, so an order has been placed with a



prominent manufacturer to make them, which is to be done at a reasonable price. They are made of transparent celluloid with the graduation on the under side. A few extra ones are now on hand as it was necessary to order more than were wanted. C. E. JOSSELYN.

Bridgeport, Conn.

* * *

Don't take a heavy stock cut off with a planer and then a finishing cut without letting up on the work and allowing all of the strain to come out.

* * *

Don't forget that after the stock cut is made on cast iron, every finger mark, or drop of water, or drop of oil, will show up when the finishing cut is made.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

253. CEMENT FOR FASTENING TOOLS IN THEIR HANDLES.

Mix one part beeswax, one part fine brick dust and four parts black rosin. E. H. McCLINTOCK.

West Somerville, Mass.

254. TAPPING HOLES IN CAST IRON.

Kerosene oil used as a lubricant for tapping holes in cast iron is the best lubricant known to the writer.

Philadelphia, Pa. WM. DAVIS.

255. ACID-PROOF CEMENT.

Mix a concentrated solution of soda with pulverized glass to form a paste. W. R. BOWERS.

Birmingham, England.

256. FLUX FOR BRASS.

One ounce common soap, ½ ounce quicklime, ¼ ounce saltpeter. Mix into a ball and place in a crucible when lifted out of the furnace. This is sufficient for about 50 pounds of metal. W. R. BOWERS.

Birmingham, England.

257. DUSTING FOR MOLDS FOR BRASS WORK.

To produce light castings of brass and gun-metal with a clean face and fine skin, first dust the mold with pea meal and on top of same add a slight dust of plumbago; for heavy castings dust only with plumbago. W. R. BOWERS.

Birmingham, England.

258. A LUBRICANT FOR CUTTING THREADS.

After trying various kinds of lubricants in cutting threads on tool steel, machine steel, etc., I found that common lard (not lard oil) mixed with about one-third turpentine gave the best results. The mixture may be applied with a small brush.

Paterson, N. J. STEPHEN COURTER.

259. ANTI-SLIP BELT MIXTURE.

To make a cheap anti-slip belt mixture and one that is very effective, use 95 per cent rosin and 5 per cent machine oil. Melt the two together slowly, taking care not to burn the rosin. When melted stir together thoroughly and apply warm, using a little at a time while the belt is running.

Pittsburg, Pa. SAMUEL STROBER.

260. BLACK BRONZE FOR BRASS.

Dip the article, cleaned bright, in aquafortis (nitric acid); rinse the acid off with clean water, and place it in the following mixture until it turns black: Hydrochloric acid, 12 pounds; sulphate of iron, 1 pound, and pure white arsenic, 1 pound. It is then taken out, rinsed in clean water, dried in sawdust, polished with black lead and lacquered with green lacquer. JOS. M. STABEL.

Rochester, N. Y.

261. SELF-LUBRICATING BEARINGS.

In hard gun metal bushes, bored a good fit to shaft and split, drill four holes per square inch of surface, each ¼ inch diameter by ¼ inch deep. The holes are to be flat at the bottom and to be spaced zigzag, so that one row of holes is between the holes in the opposite side thus: . ˙ . ˙ . Fill the holes with a compound prepared as follows: Melt 1 pound solid paraffine and add 2 ounces of litharge, dissolved isinglass and sulphur; add further 2 pounds of fine plumbago and mix thoroughly. J. H. HOLDSWORTH.

Toronto, Canada.

262. VARNISH FOR DRAWINGS.

Dissolve by gentle heat 8 ounces of sandarac in 32 ounces of alcohol. Another receipt is: Dissolve 2 pounds of mastic and 2 pounds of a lammar in 1 gallon turpentine without heat. The drawings must first be sized with a strong solution of isinglass and hot water. W. R. BOWERS.

Birmingham, England.

263. TO WATERPROOF CLOTH TOOL BAGS OR CASES.

To waterproof tool bags or cases made of duck or other cloth, either of the following formulas may be used.

Use ½ pound of alum and 2 ounces of saltpeter dissolved in 1 quart of water. Immerse the article to be waterproofed in this mixture for 40 minutes, and boil hard; then rinse in cold hard water, hang up and let dry thoroughly before using.

Melt ½ pound of paraffine wax and mix in 1 quart of gasoline. Immerse the article in this and wring out and spread out to dry. In a short time it is ready to use.

E. W. NORTON.

264. CEMENT FOR LEATHER BELTS.

To prepare a good cement for leather belts, soften equal parts of good hide-glue and American isinglass in warm water for about 10 hours. Mix the two ingredients together thoroughly and then pour on a quantity of pure tannin and boil until the mass is sticky. Just enough tannin should be added so that the mass will have a good consistency when boiling hot. To apply the cement, roughen the surfaces to be cemented and apply the cement while it is very hot. Press the parts together firmly and hold in that position until dry.

Olney, Ill. T. E. O'DONNELL.

265. SOLDER PREPARATION FOR ALUMINUM.

The most successful solder preparation for soldering aluminum yet secured is made up in the following manner. Melt together 64 parts, by weight, of tin, 30 parts of zinc, 1 part of lead, and a small amount of rosin. All parts, of course, must be mixed together very thoroughly while in molten condition. When thoroughly mixed the alloy should be run out in bars of desired sizes. Clean the surfaces thoroughly and apply the solder. No chemical is required, the rosin used being sufficient to cause adhesion, although it is advisable to heat the parts to be soldered gently to assist in making a good adhesion. T. E. O'DONNELL.

Olney, Ill.

266. TO BLUE STEEL WITHOUT HEATING.

When it is not desirable to blue steel by the heat process the following solution may be used with excellent results: Water, 1 quart; hyposulphite of soda, ½ ounce; acetate of lead, ½ ounce. Dissolve the acetate of lead and hyposulphite of soda in the water and then heat to the boiling point. The article to be blued should be thoroughly cleaned and dipped into the hot bath until the color changes to the required tint. It should then be removed, rinsed and dried. A more brilliant result is obtained by coppering steel articles with blue vitriol solution and then dipping. The same process may be used on both brass and copper with success. M. E. CANEK.

267. SOLDERING WITHOUT HEAT.

Take 1 ounce of ammoniac and 1 ounce of common salt, an equal quantity of calcined tartar, and 3 ounces of antimony. Pound this well together and sift. Put this in a piece of linen, and enclose it well around with fullers' earth about an inch thick; let it dry, then put it in one crucible, covered by another crucible over a slow fire to get hot by slow degrees. Keep up the fire until the content of the crucible gets red hot and melts. Then let it cool gradually and when cold pound the mixture. When you wish to solder anything put the two pieces you want to join together on a table close to one another. Make a crust of fullers' earth, so that, passing under the joint and holding to each piece it shall be open at the top. Then throw some of the powder between and over the joint. Dissolve some borax in some hot wine, and with a feather dip in the solution and rub the powder at the place of the joint. It will immediately boil up. As soon as the boiling stops the consolidation is made. The calcined tartar is made by placing crude tartar in a covered crucible and raising it to a low red heat. Allow it to cool gradually.

Rochester, N. Y. JOSEPH M. STABEL.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

27. H. T. M.—What are the precise advantages of the bull-wheel used in planer construction. Do these advantages exist when the bull-wheel and the rack are cut with ordinary gear cutters?

A.—The use of the bull-wheel in planer work is largely because of constructive reasons. If the rack be meshed directly with the driving pinion, one of the reduction gears must necessarily extend above the level of the platen unless the rack be carried low. The introduction of the bull-wheel allows the reduction gearing to be all below the platen, and also gives the advantage, if it be one, of a large pitch circle to work with the rack; consequently the lifting action of the bull-wheel on the table is not as great (with the cycloidal tooth system) as it would be if a pinion were employed. With the involute tooth system, however, the angle of pressure remains unchanged for large or small gears so that this feature is really of not much importance. One successful American planer (Whitcomb-Blaisdell) is made without the bull-wheel.

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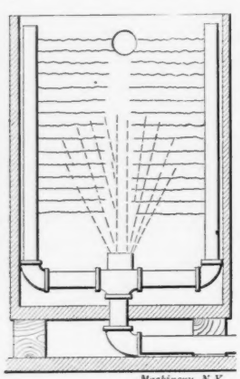
28. F. S.—1. How should a square wire spiral spring 5¼ inches long, 24 coils, 0.525 inch outside diameter, wound on a mandrel 0.35 inch diameter, wire 0.080 inch square, be hardened? This spring must be compressed into a square of 2 inches and must extend to its full length. The steel is 0.65 carbon. 2. How should tool steel rolls for rolling wire to a thickness of 0.023 inch thick by 0.237 inch wide be hardened? The rolls are 8 inches diameter by 4¾ inches face and have a hole through the center for a shaft 3½ inches diameter. They must be so hard that a file cannot touch the face and must be free from checks or cracks. The steel is 1.10 carbon.

Answered by E. R. Markham, Cambridge, Mass.

A.—1. In treating springs the desired final condition is elasticity and not hardness. Many times the hardener makes the mistake of getting springs too hard—and too brittle. Then in reducing brittleness the temper is drawn too low in order to let the spring stand up to its work; if the temper is not drawn low the spring breaks. When possible springs should be hardened in oil. If oil does not produce the desired result water must be applied instead, but it should be kept as warm as possible and still produce the desired hardness. Oil will work in most cases where the wire is no heavier than that stated in the inquiry, and even where it is several times the size, if the carbon content is sufficiently high. When oil fails to give the desired results it is generally because of lack of circulation or what is known as a "still" bath. Various expedients are employed to keep the oil in motion, but the best results follow when it is forcibly brought in contact with all parts of the steel alike, and this is accomplished in the case of a spring of the style under consideration by employing a bath of the form shown in the accompanying cut. There are six or more pipes extending up the side; these are perforated and the oil is forced through the opening toward the center. The pipes are so arranged that they may stand close to the sides of the receptacle or be swung toward the center for small work. The oil being projected against all parts of the spring alike insures uniform hardening and avoids the evils arising from the formation of gas next the work as occurs in a still bath. The stream of oil coming from the bottom also further agitates and forces the heated oil and gases to the top of the bath from which it is drawn off by a pump through cooling coils immersed in a tank of running water and then forced back through the hardening bath. Either lard or sperm oil works well, or in fact almost any fish oil answers nicely with such an arrangement. When drawing the temper best results follow if the springs are placed in a kettle of oil and the contents heated to the proper degree as denoted by an accurate thermometer. The exact temperature required cannot be stated as a great deal depends on the kind of steel used, the heat at which the spring was hardened and the use for which the spring is designed. However, if the spring be properly heated when hardened the temperature should not range far from 580 to 630 degrees F. For steel of the carbon content mentioned the first figure mentioned should be about the required temperature. 2. The hardening of rolls of the kind and purpose mentioned is not boy's play; it calls for experience and expert handling. A good grade of steel is required and one low in harmful impurities. The rolls must be carefully annealed before the machine work is completed. After boring the hole ⅛ or ¼ inch smaller than the finished size and turning off the outside surface or skin carefully, anneal the roll to remove all internal strain and then finish to size. When hardening the roll it must be carefully and uniformly heated; rapid heating is to be avoided as the outer surface at the ends will be heated much more rapidly than the balance of the piece. Rapid heating of such a piece means uneven heating and uneven cooling, consequently severe internal strains and bad results. If the carbon content is 1.25 or under, the roll should be packed in an iron hardening box with charred leather, and in charred hoofs, or charred hoofs and horns if it exceeds the percentage mentioned. The cover should be luted with fireclay and the box placed in a well-designed furnace where a uniform heat can be obtained. When uniformly heated it may be hardened in a bath of the description shown in the answer to question 1, using water or brine instead of oil. A jet of water from the faucet or hose should be allowed to play down upon the surface of the bath, as otherwise the end of the roll that is uppermost in the bath will not cool as rapidly as the remainder. Hence, uneven contraction will result. When dipping in the bath the rolls should be held by a rod passing through the shaft hole. It is possible to pack several rolls in one hardening box and to heat several boxes at a time in an ordinary furnace, thus making the cost of heating comparatively low. After hardening immediately remove the tendency to cracking from hardening strains by reheating over a fire, turning the roll while heating to insure uniform temperature throughout; heat until a drop of water will form steam when placed on the surface. Allow the roll to cool in a dry, warm place where no current of air can reach it. In conclusion would say that unless a shop is provided with suitable equipment for doing this work and great care is devoted to it the results will be unsatisfactory. Probably no one class of hardening has given more trouble in the past than this.



Machinery, N.Y.

* * *

An example of the beneficent effect of any medium that reduces shock and vibration is found in the rubber-tired carriage. Rubber tires for carriages have come into extended use during the past few years. They have the advantage of not only being noiseless, but the wear and tear on the body and wheels are greatly reduced. The shock to steel tires on an ordinary country road eventually loosens the spokes and wears the felloes, but with rubber tires all small obstructions are met yieldingly by the tires and the impact absorbed without transmitting the vibration to the wheels or body. It is claimed that while rubber tires are more expensive in the outset and for maintenance, the reduction in running repairs to other parts of carriages makes their use a positive economy.

* * *

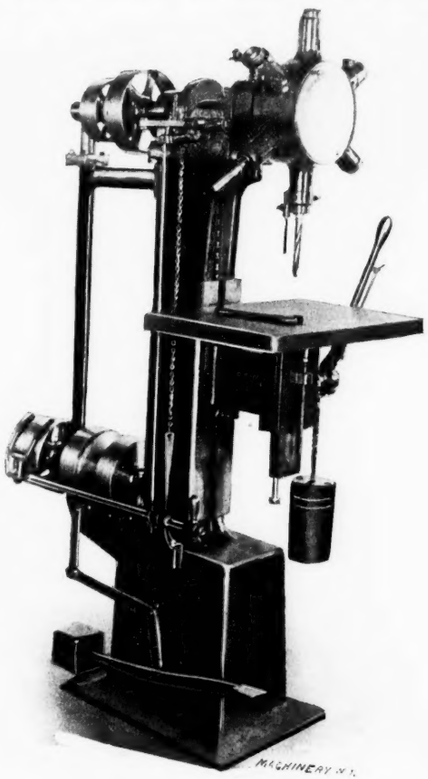
The enormous proportions of the Krupp Works at Essen, Magdeburg, Kiel, Annen and other places in Germany is more easily apprehended when it is considered that these works, and the coal mines operated in connection with them, had on the first of April, 1906, in their employ more than 62,500 persons, of whom more than 5,000 were officials and clerks. The company's principal plant in Essen consumes during one year as much water as does the entire city of Dresden, which has a population of over 400,000 inhabitants. It is also of interest to note for comparison with conditions in the United States that the average daily wage paid in 1905 to the workers in the cast steel plant was $1.22 per person.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

IMPROVED TURRET DRILL.

A. E. Quint, of Hartford, Conn., has redesigned his well-known turret drill, introducing, among other improvements, an improved feed arrangement to the work table, involving the use of a ratchet hand lever with an adjustable counterbalance which may be accurately adapted to work of any weight. The head follows the usual construction in this machine, and may be made for 6, 8, 10 or 12 spindles, of which only the one in actual use rotates. The machine is provided with back gears and reversing friction clutch for tapping, the clutch being operated by the pressure of the foot on the pedal for the reverse movement. The release of the foot allows the forward clutch to engage itself. The machine allows a maximum distance of 20 inches between the table and the end of the spindle. The distance from the center of the spindle to the face of the column is 8¼ inches, the size of the table is 14 x 20 inches, and the weight of the machine ready for shipment is 840 pounds.



Quint Improved Turret Drill.

HEAVY AUTOMATIC PINION CUTTING MACHINE.

The machine of which a front view is shown in Fig. 1 and a rear view in Fig. 2, is built by the Eberhardt Bros. Machine Company, 66-68 Union Street, Newark, N. J. As indicated by the title, it is particularly designed to cut steel pinions of coarse pitches at a fast rate of feed, as fast, in fact, as the cutters will stand. It is therefore adapted to manufacturing purposes where quantities of similar gears are required to be cut, as in the case of car motor pinions, and for jobbing as well, since the machine is capable of cutting the coarse pitches in iron, bronze and steel up to its capacity, which is 30 inches in diameter. Ordinarily when buying a machine for cutting pinions exclusively, in order to obtain a strong enough spindle drive to cut 2 or 3 diametral pitch in steel with heavy feed, the purchaser has been forced to pay for a machine capable of taking a 60-inch gear at the least, even though his work may be entirely confined to small diameters. The machine shown herewith is in fact practically a 60-inch machine furnished with a short column and simplified in many details that would need to be elaborated somewhat if the full capacity were used. One of the simplifications to which attention might be called, for instance, is the arrangement of the elevating screw and hand wheel for the work spindle saddle, this arrangement being possible on account of the shortness of the column.

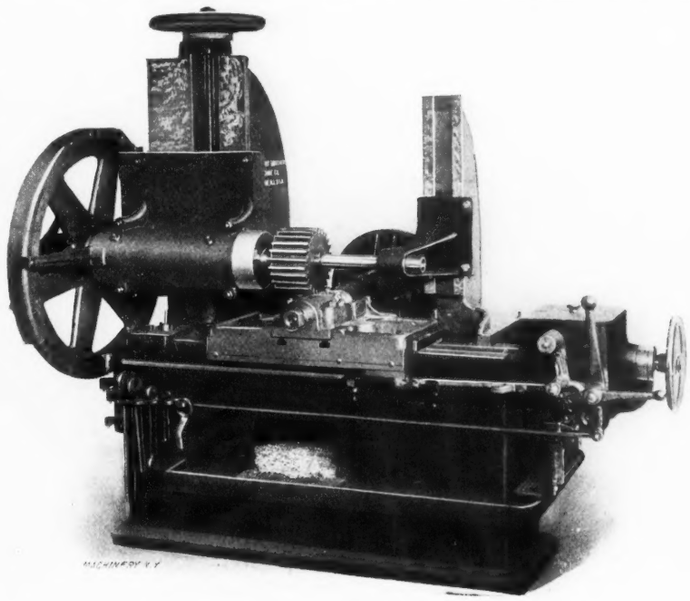


Fig. 1. Automatic Pinion Cutting Machine. Front View.

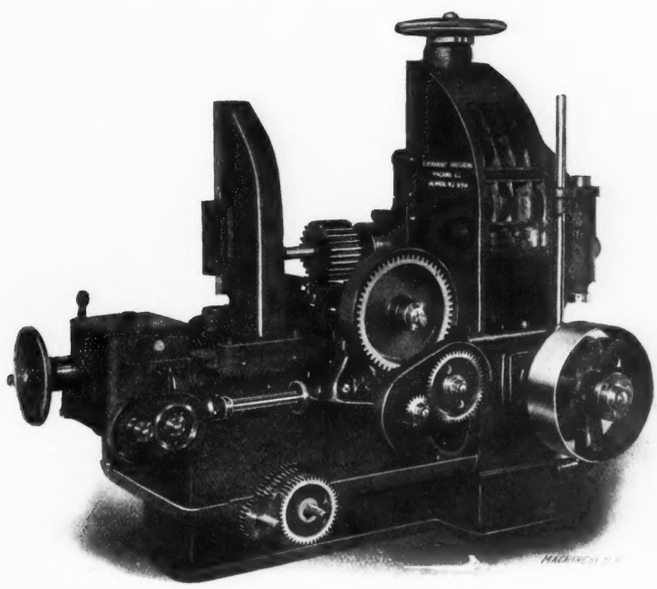


Fig. 2. Automatic Pinion Cutting Machine. Rear View.

Three of the prominent features of the design are the exceptionally long cutter slide with the spindle in the center, the placing of the thrust for the feed screw at the column end of the bed so that the slide is pulled instead of being pushed (a principle used throughout the design), and the unusually rugged drive for the cutter. In addition, the indexing and feed mechanisms are so constructed that the engagement of one precludes the simultaneous engagement of the other, thus

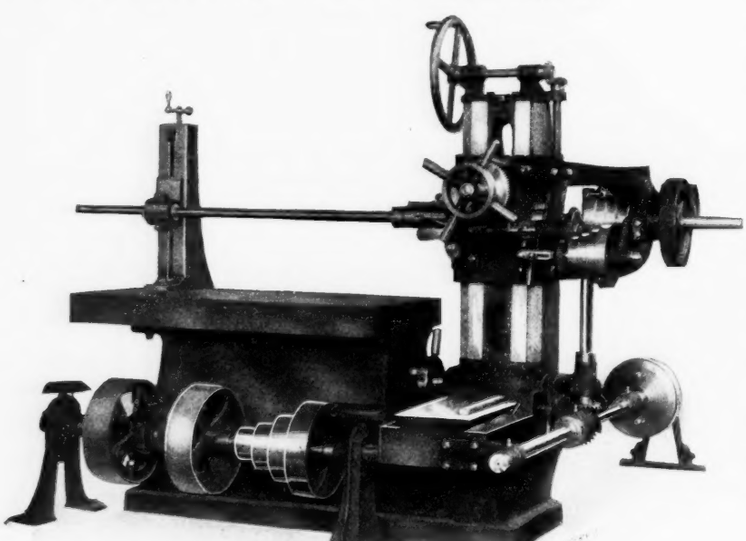
while the machine is indexing it is impossible for it to feed, and while the machine is feeding the indexing lever cannot be operated. These movements are automatically interlocked whether the machine is running or whether it is being adjusted by the workman.

The spindle driving arrangement is well shown in the rear view, Fig. 2. A large spur gear is mounted on the spindle, which is a tool steel forging of large diameter, and this gear in turn meshes with an elongated pinion below it, thus providing for lateral adjustment of the spindle and driving gear as a whole, and doing away with the necessity for a sliding key or keyway at this point. This lateral adjustment is so great, in fact, that it is possible to mount a roughing and a finishing cutter side by side on the arbor, as is done in the machine here illustrated. The changes in cutter speeds are obtained by change gears mounted as close to the spindle as possible. This permits the driving shafts to be kept at a constant high speed, subjecting them only to a comparatively light and unchanging torsional strain. The cutter speeds and feeds are, of course, independent, so that one may be changed without affecting the other. The spur gear for the spindle drive was adopted on account of its smooth running and high efficiency, as demonstrated by experiment.

The indexing wheel is of very large diameter, as can be seen, especially when compared with the range of work the machine is intended for. It is of the generated type and made very accurately. A graduated dial is provided reading to thousandths of an inch to facilitate the accurate setting of the depth to be cut. The work arbors are drawn in and forced out by means of the bolt at the rear of the work spindle. The frame of the machine is constructed to form an ample reservoir for the cutting lubricant. A special guard close up to the cutter compels the chips to fall directly into the base of the machine, from which they are removed either at the side or the front. Suitable strainers are provided for separating the chips from the lubricant.

NO. 2 BARNES HORIZONTAL DRILL.

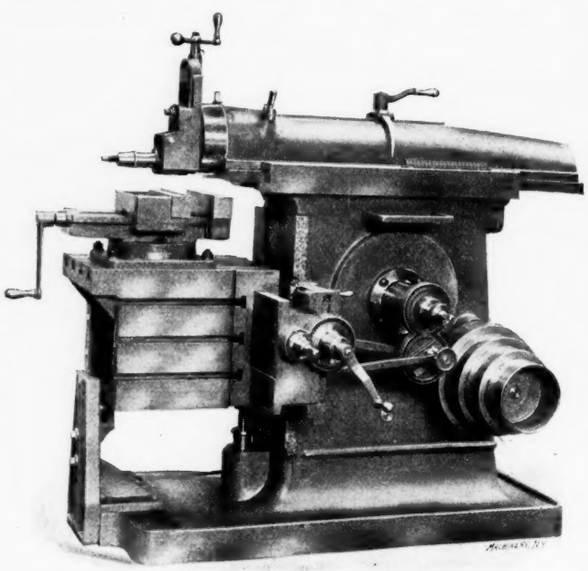
The horizontal drill shown in the accompanying halftone is a recent product of the B. F. Barnes Co., Rockford, Ill. Its general arrangement is that of a horizontal boring machine. It has a stationary table 24 x 48 inches, to which the work is clamped. The spindle is carried by a vertical adjustable saddle on a laterally adjustable column and has a longitudinal feed of 19 inches. The vertical adjustment of the spindle head is 18 inches. The feeding mechanism, located on the saddle, is power driven with an automatic stop, or may be operated by a hand wheel. All clamping levers and adjusting hand wheels are conveniently located and readily accessible to the operator from the front of the machine. A reversing friction countershaft is supplied with the machine. The spindle can be used at any point on a surface 36 inches long by 18 inches high. The spindle is 2 1-16 inches in diameter and is bored for a No. 5 taper. The cone pulley, for 3-inch belt, has the well-known internal back gear device used by this firm on its other drilling machines. The machine requires a floor space over all of 7 feet 6 inches by 8 feet 6 inches and weighs about 3,800 pounds net. The outboard boring bar support shown in the cut is furnished at extra cost.



No. 2 Barnes Horizontal Drill.

TWENTY-ONE-INCH AVERBECK SHAPER.

The shaper shown in the accompanying halftone and built by the H. J. Averbeck Shaper Co., 52-56 E. Second Street, Covington, Ky., presents in its construction several unusual features. One of the most striking is the provision of an automatic stop for the table feed. A rod extends from end to end of the cross rail and on this are mounted adjustable dogs which come in contact with the table as it is fed in either direction, the resulting movement of the rod throwing the feed mechanism out of engagement. This enables the operator to adjust the machine for any length of cut he desires. Two stationary dogs are also provided which cut off the feed at the extreme travel of the table in either direction, so as to avoid all possibility of breakage of any part of the feed mechanism. The lever seen just above the gearing at the back of the rail is used to engage, disengage or reverse the feed. A "two to one" gear ratio is provided in the feed gearing which allows either a quick return or slow hand feed. Another novelty is in the design of the table support. This consists, as may be seen from the cut, of a vertical knee bolted to the base, carrying a roller in a vertically adjusted bracket on which the table is free to feed either to the right or to the left. This arrangement, while giving a firm outboard support, places the bearing surface in a position where it is not liable to be clogged with chips. The table is slotted on both top and sides, there being four of these slots on the top. The vise provided may be clamped on either side of the table or the table removed and the work clamped on the saddle.



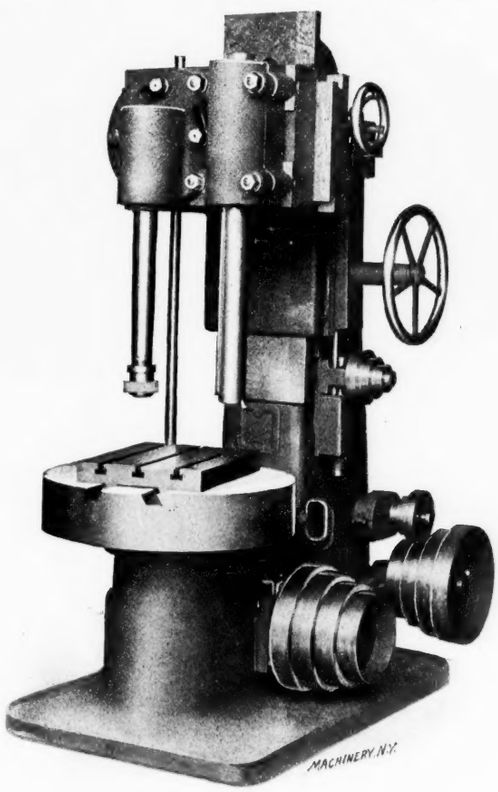
Twenty-one-inch Averbeck Shaper.

The machine shown, which has a 21-inch stroke, may be shifted at will to work at a gear ratio of either 18 to 1, or 5 to 1. This, in connection with the 4-step cone, gives eight cutting speeds to the ram with a range of from 8 to 84 strokes per minute. The cross feed connecting rod is automatically

adjustable to any height of rail through the operation of the guide rod. The length of the stroke and position of the ram can be changed at any time from the working side of the machine. The extreme length of stroke is 21½ inches, the horizontal travel of the table is 26 inches, the vertical adjustment is 16 inches, while the feed of the tool block is 8 inches. The machine will take a 3⅛-inch shaft under the ram for key seating. The top surface of the table is 21¼ x 16 inches and the weight of the whole machine is about 3,200 pounds.

SAXON CYLINDER GRINDING MACHINE.

The Saxon Machine Co., 32 Main St., Room 10, Holyoke, Mass., have designed the machine illustrated for the special purpose of performing internal grinding operations on gas and gasoline engine cylinders, air compressor cylinders, and other similar surfaces which must be true, in good alignment, and accurately finished. It grinds to the center of a 24-inch circle and to a depth of 18 inches, regardless of the shape of the



Saxon Cylinder Grinding Machine.

work. The machine has, as will be seen, the general form of a vertical boring mill, including as it does an upright column provided with a slide for carrying the grinding spindle, with a rotating table at the base to which the work is attached. The main frame is a solid casting with a base for the face-plate and a column for the cross rail. The revolving face-plate has its bearings well protected from dust and is driven by the cone pulleys on the right side of the machine. It can be furnished with two sets of three T-slots each, crossing each other at right angles, or will be provided with a sliding table as shown. With this latter arrangement, duplex cylinders can be ground without altering the setting of the work. The cone pulleys provide eight speeds for the table. If desired, a geared speed box may be used in place of it.

The grinding spindle is of crucible steel, accurately turned and ground, and is carried by a sliding head attached to the cross rail. The bearings are of a special metal superior to phosphor bronze for this work. They are adjustable and protected from the dust. The feed of the head on the cross rail is accomplished by a screw with a dial graduated to thousandths of an inch. The traverse of the head is automatic, being controlled by a reversing rod actuated by dogs, which may be placed in any desired position, or it may be operated by hand with a lever provided for that purpose. Six rates of speed are provided for each speed of rotation of the work. These are obtained by the small cone pulleys shown or by a geared speed box, which will be furnished instead if so ordered. All the adjustments can be made from the operating

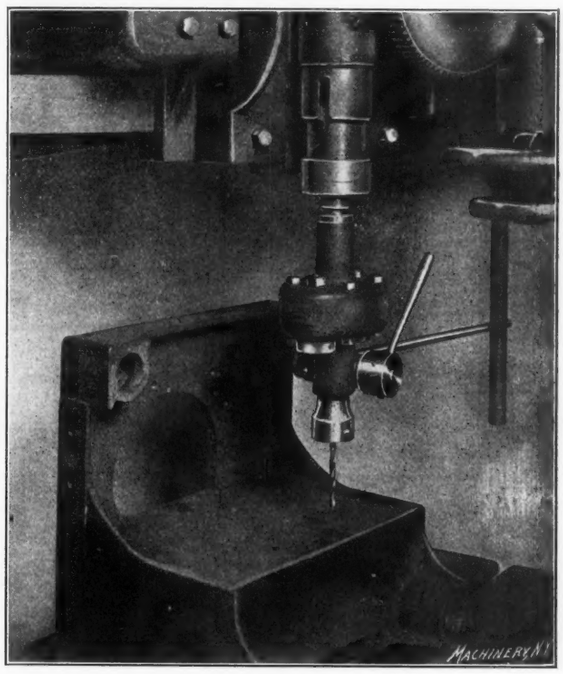


Fig. 1. Graham Drill Speeder in Operation.

side of the machine. The boring bar is an extra attachment which converts the machine into a boring mill for the roughing operations. The net weight of the machine is about 4,000 pounds.

THE GRAHAM DRILL SPEEDER.

Fig. 3 shows a halftone and Fig. 2 a line cut of the device shown in operation in Fig. 1. Its makers, The Graham Mfg. Co., Providence, R. I., call it a "drill speeder," and its purpose, as indicated by its name, is to allow the use of small drills at high speeds in machines which would ordinarily be too heavy and slow of movement for the work desired. A

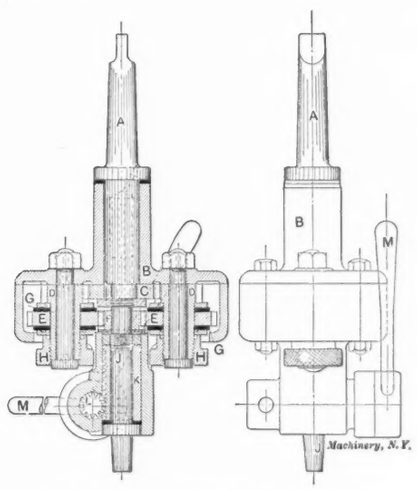


Fig. 2. Design of Graham Drill Speeder.

common condition met with by the machinists in the ordinary run of work is that of drilling oil holes 1-16 or ⅛-inch diameter in large castings which have considerable work to be done on them by the radial drill. Not only does the spindle of such a machine move too slowly for the work desired, but there would be difficulty in safely feeding so small a drill

with the large feed mechanism. This device gives, in such a case, the requisite speed and the required sensitiveness of feeding. The main body *B* is of cast iron. The upper part forms a bearing for the spindle *A*, which has a tapered shank and fits in the hole in the end of the machine spindle. The lower end of the casing forms a bearing for sleeve *K*, which carries the high-speed spindle. This sleeve is fed by the small pinion *L* with its attached handle *M*, in the same way that a sensitive drill press spindle is fed. A spring is provided which always returns handle *M* to its upper position. The high-speed spindle *J* is splined for a key in pinion *F*, but is free to move up and down, the upper end having a bearing within main spindle *A* as shown by the dotted lines. Gear *C* keyed to the lower end of spindle *A* through gears *D* and *E*, drives pinion *F* and through it spindle *J* at an increased rate of speed, in a way that will be readily understood from the cut. Gear *E* is not keyed to the hub on pinion *D*, but is prevented from turning on it by the pressure of friction washers *G*. This friction may be adjusted to any required degree by means of knurled nuts *H*, which project through the lower side of the gear casing.

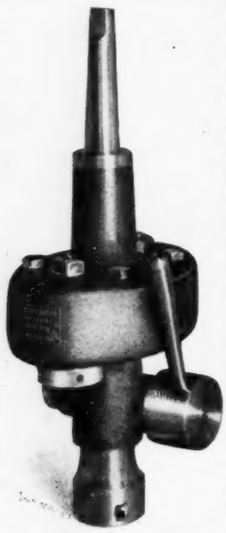


Fig. 3 Graham Drill Speeder.

The device shown is the result of evolution, various designs having been tried out until a satisfactory arrangement was developed. The speeder is made in two sizes. No. 1 size has a speed ratio of 4 to 1 with a capacity for drills up to ¼ inch. The shank has a No. 3 Morse taper, with the speeder spindle fitted for a standard chuck. The length exclusive of the taper is 8½ inches and the weight 14 pounds. The No. 2 has a ratio of 3 to 1, with a capacity up to ½ inch. Its weight is about 18 pounds.

THE CATARACT BENCH MILLING MACHINE.

The bench milling machine shown in Fig. 1 is manufactured by Hardinge Bros., 1034 Lincoln Ave., Chicago, Ill., and is designed for general use by watch and clock manufacturers, instrument and toolmakers, and others having small accurate work to do. It is made, in part, of attachments provided for the new Cataract bench lathe, the headstock being the same as that used for the lathe; it has a half-inch hole through the spindle. The table of the machine can be lowered to 7 inches from the center of the main spindle; it is 12 inches long and is provided with three T-slots. All the screws have dials graduated to thousandths of an inch, making the machine valuable for use in laying out jigs and in die work.

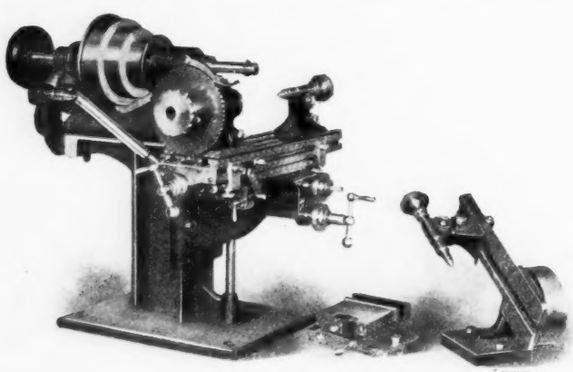


Fig. 1. Hardinge Bros. Bench Milling Machine.

The dividing head is 2½ inches from the center line to the table, and it carries a 4-inch index plate. The spindle is bored to receive a split chuck of the same design as that used in the lathe headstock and in the spindle on the same machine. This dividing head may be used in connection with the adapter shown at the right in the cut. This device allows the tailstock and index head to be set together at any angle up to 45 degrees, making it suitable for taper reamer and tap work. A small vise is provided for this machine, so that a great variety of operations may be easily performed.

The milling attachment to the regular Cataract bench lathe is built, as shown in Fig. 2, on the same general lines, being identical in every respect with the exception of the main frame. It will be noticed that to get the proper height for the frame above the bench the head stock is raised 3 inches above the top of the bed. Attention is also called to the countershaft arrangement here shown, which is provided with the lathe when desired. This countershaft has a cone at the right which is driven by a pair of gears and may be raised to the proper amount, so that the head can be taken from the bed and placed on the milling machine attachment without having to change the length of the belt. The same attachments as are used with the lathe are adapted for use with the milling machine.

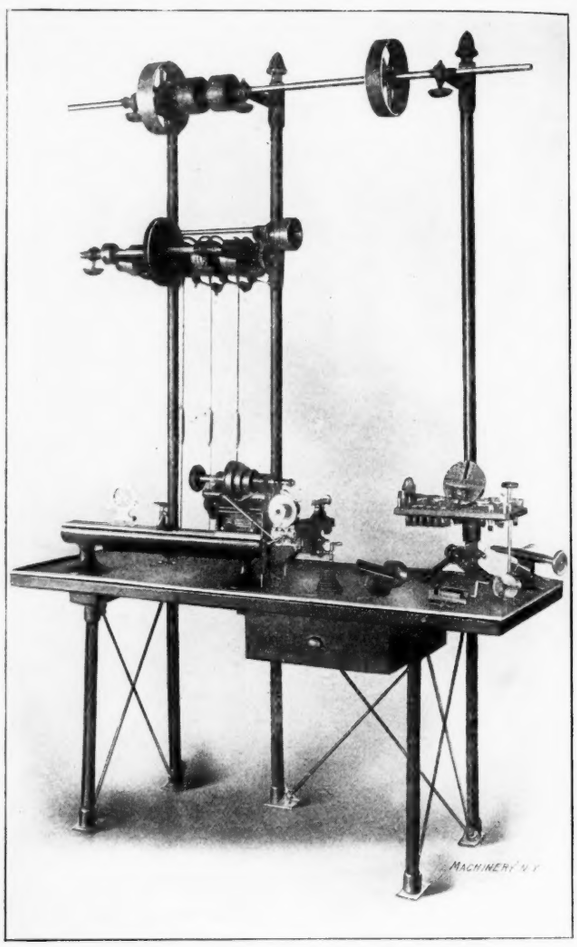


Fig. 2. Hardinge Bros. Bench Lathe Milling Attachment.

STANDARD 14-INCH CHAMPION ENGINE LATHE.

This lathe, of which a halftone view is shown in Fig. 1, is the product of the Champion Tool Works Co., 2420 Spring Grove Ave., Cincinnati, Ohio, and is designed to meet present-day conditions. The spindle, which has a 1 9-16 inch hole throughout its length, is of hammered crucible steel with round journals revolving in phosphor bronze boxes. Feeds can be reversed in either the apron or the head, and the apron mechanism is so arranged that the rod and screw feeds cannot be engaged at the same time. As shown in Fig. 2, lever *B* engages the slot in quill *D*, which is mounted on the splined feed rod. This quill carries the two bevel gears, *E* and *E'*, either of which may thus be made to engage with large bevel

gear F of the feed gear train in the apron. Only when lever B is in the central position, and the bevel gears E and E' are out of mesh with gear F, can split nut $C\,C'$ be closed upon the lead screw. The automatic stop is actuated by collars on the splined feed rod which may be clamped at any point on its length. This feed rod W has a limited end movement in either direction from the central position shown. Springs X and X',

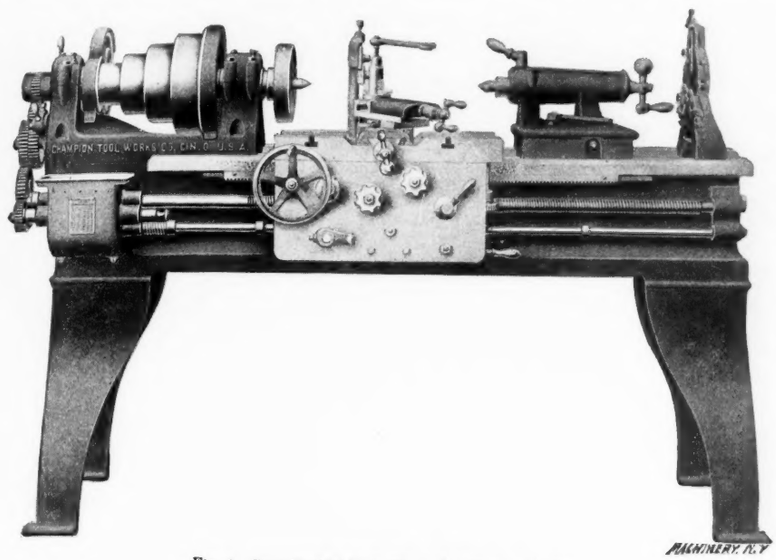


Fig. 1. Standard 14-inch Champion Engine Lathe.

bearing on collars Y and Y', keep the rod in this central position normally. Gear U revolves loosely on W and is driven by gear T on the shaft above it. This gear U is provided with an internal chamber having clutch slots adapted to engage with a transverse driving pin in the feed rod. When the feed rod W is shifted to either side of the central position by the apron mechanism striking either of the adjustable collars, the driving pin is disengaged from the clutch slots in U and the motion of the rod is arrested. Either of gears Q, R, and S may be engaged with a mating gear on shaft O, thus giving three changes of feed.

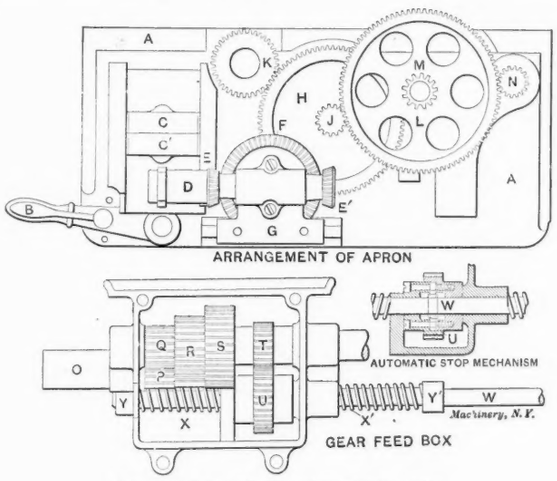


Fig. 2. Details of Champion Engine Lathe.

The machine, as shown in Fig. 1, has a 6-foot bed with a swing of 15 inches over the ways. The four-step cone is designed for a 2½-inch belt. The back gear ratio is 9 3-16 to 1. The net weight of the lathe with a 6-foot bed is 1,500 pounds.

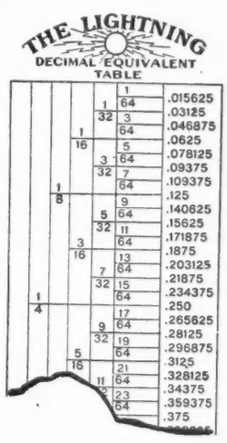
ADDITIONS TO THE LINE OF BICKFORD PLAIN RADIAL DRILLS.

In MACHINERY for January, 1906, was published a description of a line of plain radial drills developed by the Bickford Drill and Tool Co., Cincinnati, O. One of the prime features of the design was a speed change device in which the gearing was so proportioned that the revolutions per minute for any size drill is obtained with a great degree of exactness. The arrangement of the mechanism was also such that changes could be made instantly without shock, even while the machine was running at full speed. The 4-foot, 5-foot and 6-foot sizes of the Bickford plain drills have been redesigned along similar lines, the principle of the speed box being identical with that on the smaller machines. A somewhat different arrangement of the head is used on these larger sizes, however.

The feeding mechanism furnishes eight rates of feed ranging in geometrical progression from 0.007 to 0.064 inch per revolution of the spindle. Any one of these feeds is instantly available. The tapping mechanism is located in the head and permits the backing out of taps at any speed with which the machine is provided, regardless of the speed used in driving them in. It is operated by a friction clutch controlled by a lever within convenient reach of the operator. A depth gage is provided, which serves a double purpose. It is in the form of a graduated circular T-slot in a disk geared with the feed rack in such a way that its relative position with relation to the spindle is always constant. Besides enabling the operator to read all depths from zero without the usual delays necessary when scaling or calipering, it supplies a convenient means for setting the automatic trip. The graduations show exactly where each should be located to stop the feed at the desired points. This trip operates at as many different points as there are depths to be drilled at one setting of the work. In addition, it leaves the spindle free to be advanced or raised throughout its full length without disturbing the setting of the dogs. It also throws out the feed when the spindle has reached the limit of its movement.

HANDY TABLE OF DECIMAL EQUIVALENTS.

W. E. Gould, 142 Hazelwood Avenue, Detroit, Mich., has devised and copyrighted the "Lightning Table of Decimal Equivalents" of which a section is shown in the accompanying line cut. The original is about 4 inches long and has its edge graduated after the fashion of a 1-inch rule, although, of course, this makes the scale four times as great as the original. Each of the different fractions up to 1-64th, namely, the halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths, has its own column in which the fractional quantity is placed. The decimal equivalents are in a vertical column at the extreme right. This arrangement is very convenient for quick reference, since it takes advantage of the user's already acquired quickness in reading a rule graduated in the ordinary manner, and has all fractions of the same denominator arranged in the same vertical column. It should prove useful to machinists, draftsmen, etc., and may be tacked up on the belt shifter, cemented to the T-square, or fastened in any other position for ready reference. Although printed on opaque celluloid, the marking is protected in such a way that it is permanent. The price is 15 cents.

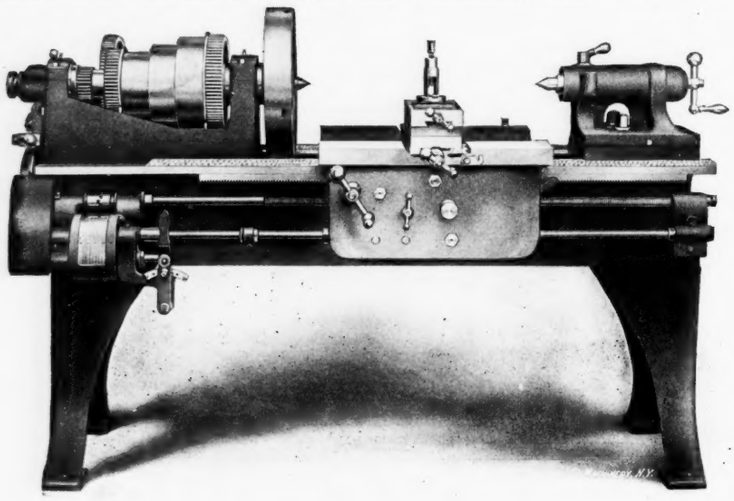


Handy Table of Decimal Equivalents.

THE WHITCOMB-BLAISDELL 16-INCH ENGINE LATHE.

This lathe is one of a new line which the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., have recently brought out to supersede the various other designs which they have hitherto built. The distinguishing features of this line are the rigidity of the design, the increase in effective belt power,

and greater facility of operation. The beds are of the box pattern. The increased power of the lathe is obtained by the use of double back gears with a three-step driving cone carrying a wide belt. Nine changes of speed are thus obtainable and the effective belt power at the different speeds is much more nearly equal than is the case where a four- or five-step cone is used. The smallest cone diameter is sufficiently great



Whitcomb-Blaisdell 16-inch Engine Lathe.

to give ample belt contact at the high speeds, so that on the other steps an excess of power is provided.

The feed mechanism has been strengthened throughout to agree with the increase in spindle power. Five changes of speed are instantly obtainable through the lever under the headstock. The friction which controls the feeds is self-adjusting and in such a position as to be easily and safely operated. An automatic stop is provided. A friction countershaft, large and small faceplates, and the necessary wrenches are furnished with each lathe. The swing over the bed for this machine is 18¼ inches, although it is rated on the 16-inch basis. There is a 1¼-inch hole through the spindle. The machine with a 6-foot bed weighs 2,100 pounds.

EVERETT McADAM CONTINUOUS ELECTRIC BLUEPRINTING MACHINE.

A new blueprinting machine of the continuous type having a number of novel and interesting features is shown in the accompanying cuts, Fig. 2 being an elevation and Fig. 1 a line cut which shows the principle of the device. The result sought in the design of the machine is the ability to use blueprint paper directly from the roll without cutting into sheets, and to feed this paper to a continuously acting machine, to which the tracings are supplied continuously and as rapidly as the printing can be done. As shown, the roll of paper is contained in a box at the top of the machine, feeding out through an opening at the bottom. The box is light-tight and protects the paper when it is not in use. In the center of the machine is a large rotating cylinder of glass within which are mounted two mercury vapor lamps whose light, intensified by a reflector at the front, is used by making the prints. Four drums are placed around this central rotating cylinder with their axes parallel with it and a series of narrow belts run over these drums and around the cylinder, in such a way as to furnish a means for tightly holding the paper and the tracing beneath it to the revolving glass surface. As shown by the arrows in Fig. 1, the tracings are inserted between the paper and the belts at the upper part of the machine, and are delivered below, both feeding and delivery being at the front. Three-fourths of the surface of the glass cylinder is utilized for printing. The glass cylinder and the belts are kept in motion by a small electric motor having a variable speed controller which may be instantly changed to suit the depth of printing desired, the sensitiveness of the paper used, or the transparency of the tracing from which the print is made.

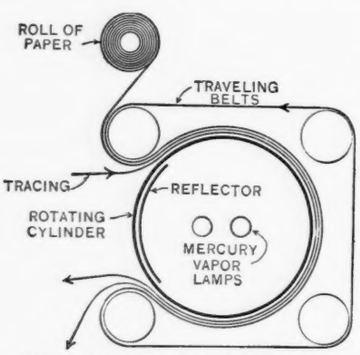


Fig. 1. Diagram of Electric Blueprinting Machine.

With this description of the machine in mind the advantages of the arrangement will be readily apparent. The blueprint paper itself, in continuous printing, is not touched by the hands; it feeds in of itself. There is no limit to the length of print which may be made. The machine being five feet long, a print may be made five feet wide and the length of a roll of blueprint paper. The mercury vapor lamp used requires no more attention than an incandescent lamp and has no carbon to renew. Inasmuch as the printing is done from the inside of the cylinder on the concave surface, all the rays strike the surface at practically right angles. All of the rays emitted by this form of lamp used are actinic, so that most effective transformation of electricity into chemical action is obtained. The machine is self-contained. To be put in operation it merely needs to be connected to the nearest electric light circuit, when both the motor and the lighting apparatus are ready for operation. Not only is this action continuous so far as the feeding of the paper is concerned, but its construction makes it unnecessary to use the "apron," found on some other machines, which has a limited

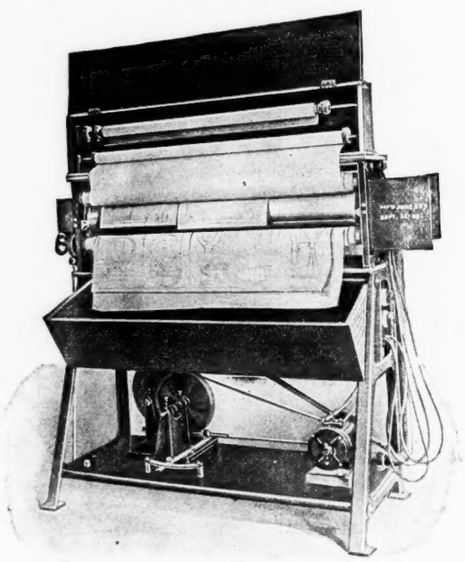


Fig 2. Everett-McAdam Electric Blueprinting Machine.

length and requires to be re-rolled after a certain period of operation, and to be renewed occasionally after a considerable period of service. It must not be thought that printing from the roll on sensitized paper is absolutely necessary; for any case where but one or two small prints are required, cut sheets may be fed to the machine in the same way as with other forms of automatic blueprinting machinery. A point which might be mentioned is that in printing from large tracings of which several reproductions are required, the leading edge may be fed back into the machine again as the trailing edge disappears, without wasting an inch of the sensitized paper, and still preserving the continuous printing feature.

The makers of this device, the Revolute Machine Co., 523 West 45th St., New York, state that, although the machine

has been on the market less than a year, there are already forty of them in daily use. The increased demand has made necessary the organization of this firm, which has equipped a shop exclusively for building them. The machine is very compact, requiring only a floor space of 2 feet by 5 feet.

* * *

DEDICATION OF THE NEW ENGINEERING BUILDING OF THE UNIVERSITY OF PENNSYLVANIA.

The University of Pennsylvania, on October 19, dedicated their new engineering building. The erection of this building was determined upon originally owing to the increasing needs of the engineering courses, and its early completion was made absolutely necessary by the burning of the former building devoted to the subject; it has been planned with the utmost care for the purposes to which it is devoted, by Prof. Spangler of the mechanical and electrical engineering courses, and Prof. Marburg, who fills the chair of civil engineering. The arrangement of this building and its laboratory equipment, in many respects unique, will be described with more or less detail in an early issue of MACHINERY.

The building, which had been decorated for the occasion, was opened for private view, throughout the day to the guests of the university. After a luncheon at 12:30 the dedicatory exercises were held in the large assembly room on the second floor. The invited guests, consisting of representatives of foreign countries and delegates from various schools and scientific societies, assembled there to witness the conferring of the degrees and listening to the addresses prepared for the occasion. The degree of Doctor of Science was conferred on Marie Michel Henri Vetillart, Alexander McKenzie, Charles Whiteside Rae, John Fritz, Mansfield Merriman, Samuel Matthews Vauclain, Frederick Winslow Taylor, Frederick Pike Stearns, Samuel Sheldon, Henry Wilson Spangler, Edgar Marburg, and Ramon Ivarrola. The addresses of the occasion were delivered by Frederick W. Taylor, who spoke on "A Comparison of University and Industrial Discipline and Methods," and by Alexander C. Humphreys, whose subject was "The Engineer as a Citizen."

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FIFTH ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The National Machine Tool Builders' Association met in New York October 9 and 10 for their annual convention, the headquarters being at the Hotel Breslin. Papers were read and discussed on various subjects of interest to the trade. One on apprenticeship was read by Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Co., being a continuation of the work started at Atlantic City last spring. The committee on apprenticeship was continued. Mr. J. N. Gunn, of Gunn, Richards & Co., New York, was introduced by Mr. Fred. A. Geier, of the Cincinnati Milling Machine Co., to speak on costs and cost-keeping. Mr. Geier added some remarks urging the desirability of a more uniform method of keeping costs in machine tool shops, and his remarks were supplemented by Mr. Rivett, of the Rivett Lathe Mfg. Co. The general report was that the machine tool business is thriving all over the country. The following officers were elected for the coming year: President, E. M. Woodward, Woodward & Powell Planer Co., Worcester, Mass.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio; first vice-president, Wm. Lodge, Lodge & Shipley Machine Tool Co., Cincinnati, Ohio; second vice-president, F. E. Reed, F. E. Reed Co., Worcester, Mass.; treasurer, W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y. The usual entertainments of the delegates were tendered by the *American Machinist* and MACHINERY. The location or time for the next convention was not definitely decided upon.

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MACHINERY'S ANNUAL OUTING.

Four hundred and thirty-odd machine tool builders, mechanical engineers and others identified with machine construction and distribution in some capacity or other, accepted MACHINERY'S invitation for its annual outing on October 10, and most of them were on the steamer *Sagamore* when she left Twenty-first Street for West Point on the forenoon of that day, the afternoon and early evening being spent on the trip, covering a distance of one hundred and eight miles. About an hour and a half was spent at the nation's Military Academy, looking over the grounds and watching the training of Uncle Sam's future lieutenants, captains, majors and generals. All who could be gathered together were grouped on a steep and slippery hill behind a battery and shot at by a man with a 12 x 22 camera. Some escaped.

These outings were instituted by MACHINERY for the purpose of bringing together people who are particularly interested in machine tools and kindred lines, so as to promote good fellowship in the trade and enable those who attend to greet their old friends and make new ones. In this and other ways the outing appears to have been a success, and MACHINERY was proud of the fine body of representative men whom this occasion brought together.

* * *

PERSONAL.

Carl H. Au, instructor in mechanical engineering, Worcester Polytechnic Institute, has resigned to accept a position with the American Steel & Wire Co., of Worcester, Mass.

Louis H. Frick, Cheyenne, Wyo., has resigned as assistant superintendent of the American District Steam Co., to accept the position of manager of the Cheyenne Light, Fuel & Power Co.

Louis Block, for twenty-four years with the De La Vergne Machine Co., New York, and for more than twenty years at the head of its engineering department, has opened an office at No. 45 East 42d Street, New York, to serve clients in the capacity of consulting engineer.

* * *

FRESH FROM THE PRESS.

HENLEY'S ENCYCLOPEDIA OF PRACTICAL ENGINEERING AND ALLIED TRADES. Edited by Joseph G. Horner. Volume 1 (A-Boi) and 2 (Boi-Fil), each containing 240 pages 7½ x 9½ inches, profusely illustrated. Published by Norman W. Henley & Son, New York. Price per volume, $6.00; $25.00 for the set of five.

This work, which is to be completed in five volumes, necessarily is broad in scope, and simple and practical in its treatment of technical subjects, being intended for everyday use by craftsmen and others having to do with practical engineering. The subjects are arranged alphabetically in the usual encyclopedia style. The complete work will contain upwards of 10,000 topics, 2,500 pages, and nearly 3,000 engravings. Mr. Horner, the editor, is a well-known English writer and compiler of technical literature, and it may be said that he has devoted his energies conscientiously to this work in review. The work, although "shoppy," is distinctly English in its tone, but this is not particularly disadvantageous, for English engineering practice is well worthy of the study of American mechanics. Many of the illustrations are halftones printed on plate paper, a feature which adds distinctly to the value and worth of the work. The subjects treated mathematically, such as thermodynamics, beams, steam, etc., were written by men who combine experience of a practical character with scientific training. The method of treatment, which has been adopted, avoids the evils of very long articles on any one subject; instead of treating the subject of engines or lathes or machine tools, for example, in one comprehensive article, a general survey only is given under those heads, and then each type of engine or lathe or machine tool is treated separately under its proper heading, such as blast engine, axle lathe, planing machine, etc. This makes the finding of a specific subject simpler than when treated exhaustively under one head.

RAILWAY ORGANIZATION AND WORKING. Edited by Ernest R. Dewsnup. 498 pages, 5 x 8 inches. Published by the University of Chicago. Price $2.00.

This book is a compilation of special lectures delivered before the classes of the University of Chicago on the subject of railway transportation during the period extending from November, 1904, to May, 1906. These were delivered by officials of various railway systems and have been brought together and edited by Mr. Dewsnup in the form of an attractive but not wholly balanced volume treating authoritatively, in a sense, upon various features of railway organization and working. The subjects by chapters are as follows: The Work of the Law Department of a Railroad Company; The Passenger Department; Railroad Advertising; Suburban Passenger Service; The Industrial Commissioner; The Problem of Handling Less-Than-Carload Freight Expeditiously and Economically at Terminal Stations; Office Work in Terminal Yards; Car Distribution and the Supervision of Fast Freight; The Problem of Car Service; Freight Claims; Some Notes on Freight Rates; Organization of the Operating Department of Railroads; The Purchasing Agent; Ballast; Railway Terminal Facilities; Railroad Signaling; Classification of Types of Locomotives; The Compound Locomotive; Car Construction; Duties of a Controller or Chief Accounting Officer; The Auditor of Expenditures; The Work of the Freight Auditor; Vitalized Statistics; Railway Development in Canada; Railway Education; Appendix.

MANUAL OF WIRELESS TELEGRAPHY, by A. Frederick Collins. 232 pages, 2¾ x 7¼ inches, 90 cuts. Published by John Wiley & Sons, New York. Price $1.50, cloth; $2.00, morocco.

The book has been written for the purpose of giving a clear idea of the principles and apparatus used in wireless telegraphy to general readers, but more especially to those who would become wireless telegraph operators or experimenters. The description of an experimental wireless telegraph which can be constructed at small expense will interest amateurs and experimenters. The elementary theory is discussed at some length, following which the book describes the various wireless telegraph systems, including the Marconi, DeForest, Telefunken, Clark, and Fessenden. A chapter is devoted to adjusting and operating the instruments which, of course, is a very important part of an operator's knowledge. Examples of the wireless telegraph alphabet, which differs somewhat from the regular Morse alphabet, are given. It includes a list of stations equipped with Marconi apparatus and a sample chart for April, 1906, showing the intersections or

points of earliest communication on the Atlantic with the various steamships equipped with a Marconi apparatus. The book concludes with a glossary of wireless telegraph words, terms and phrases. It is a readable and, we believe, reliable work on the subject and just what a practical man interested in the subject would like to get hold of.

NEW TRADE LITERATURE.

CHAS. A. STRELINGER & Co., Detroit, Mich. "Book of Tools," being a 550-page catalogue of tools, machinery and supplies.

SAXON MACHINE CO., 32 Main Street, Room 10, Holyoke, Mass. Pamphlet describing and illustrating Nos. 2 and 3 surface grinders. Dimensions for same are included.

THE TABOR MFG. CO., Eighteenth and Hamilton Streets, Philadelphia, Pa. Catalogue illustrating and describing the Tabor hinged machine, its operation, sizes and special features.

WARNER INSTRUMENT CO., 56-59 Roosevelt Avenue, Beloit, Wis. *Auto-Speed*, a monthly magazine devoted to the interests of the autometer and containing items of interest to automobilists.

NEWHALL CHAIN FORGE AND IRON CO., 9 Murray Street, New York City. Catalogue No. 101, descriptive of hand forged crane, block and hoisting chain and method of manufacture.

LATSHAW PRESSED STEEL AND PULLEY CO., Pittsburg, Pa., have issued a new folder giving price list of the Latshaw steel split pulley and illustrating the six-, twelve-, eight- and sixteen-arm pulley.

FAY & SCOTT, Dexter, Me. New catalogue No. 12, treating standard engine lathes. Special features of these lathes are outlined in the first part and specifications and illustrations of the different sizes follow.

INGERSOLL-RAND CO., 11 Broadway, New York City. Catalogue No. 45 B—Rock Drills, describes these tools in full and illustrates them working in various excavations, as the Hudson River tunnel, construction of the Eastern Chinese Railway, etc.

COATES CLIPPER MFG. CO., Worcester, Mass. Bulletin No. 20, describing worm feed drill press, flexible shaft buffing outfit, flexible speed multiplying grinder, and other apparatus for flexible transmission.

THE MILWAUKEE SCHOOL OF TRADES, Inc., 156 Clinton Street, Milwaukee, Wis., have issued a prospectus for the year 1906-1907. The book sets forth the purpose of the school, its organization, maintenance, etc., and outlines its system of instruction and the courses offered.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 69 describing a specially arranged generator for direct connection to steam or gas engines. These generators are built in sizes to give outputs of 1½ K.W. to 19 K.W. and meet the demand for small direct connected units for isolated plants and residences.

THE CINCINNATI PLANER CO., Cincinnati, Ohio, have issued a new catalogue descriptive of their line of planers. These planers have been redesigned with special reference to high speeds. Attention is also called to the variable speed planers, several types of which are illustrated.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., publish an interesting pamphlet on the subject of steam traps. It is an illustrated description of the several varieties, with valuable suggestions by W. H. Wakeman, expert steam engineer and author of well known books on steam engineering.

THE GLEASON WORKS, Rochester, N. Y., have given us something out of the ordinary in their new catalogue on gear planers. This is most attractively gotten up in its artistic arrangement and in the high grade of cuts used. The descriptive material is confined to the front of the book, halftones of the various planers following, and line cuts showing mandrels used on the planers completing the material.

E. R. MARKHAM, 66 Dana Street, Cambridge, Mass. Folder announcing that Mr. Markham will give advice in machine shop methods, designing special machinery and tools, hardening, tempering and annealing steel. Those who wish to consult him should advise him of the questions to be answered and he will notify them of the fee required.

BULLETIN No. 139, which has just been issued by the B. F. Sturtevant Co., of Boston, Mass., in its engineering series, presents a full line of generating sets driven by direct-connected vertical enclosed engines with forced lubrication. The published list contains fourteen sizes ranging from 3 to 50 K. W. in output; the former driven by a 3½ x 3 engine and the latter by a 12 x 10. All of the engines were especially designed for generator driving.

SPRAGUE ELECTRIC CO., 527 W. 34th Street, New York City. Pamphlet No. 314 on electric motors for driving ventilating fans and blowers, giving general descriptions of a few types of motors and including a list of installations of ventilating apparatus operated with the Sprague Electric Co.'s motors. Bulletin No. 219 takes up round type direct current motors. This includes description of the motors, specifications for different types and illustrations of the application of these motors to various machines.

MONTGOMERY & Co., 105-107 Fulton Street, New York City, have issued a novel form of catalogue, No. 24, listing Grobet Swiss files, machinists' hand taps, music wire, emery wheels, twist drills, etc. This matter is arranged in tabulated form on two folders pasted within a strong manila cover. The pages of the folder, starting with the one pasted to the cover, are of decreasing width so that the titles of the pages form an index, showing at a glance where the particular table or list is to be found. The convenience of the arrangement can only be appreciated by an examination of one of the folders. They are sent to any address upon application.

THE S. OBERMAYER CO., with factories in Cincinnati, Chicago and Pittsburg, have recently placed on the market a new factory riddle which is stronger and has greater wearing qualities than any riddle heretofore manufactured. The main feature of the new riddle is that the rim and liners lap; a strip of galvanized iron is bent squarely over them which prevents the joints catching and breaking when brought into contact with other objects. The name adopted for the new riddle is the "Rockwell." Descriptive circulars will be sent upon request.

THE YALE & TOWNE MFG. CO., 9 Murray Street, New York City, have conceived an original idea of assisting their dealers to market goods sold to them. They issue a booklet entitled "Suggestions for Selling Yale Padlocks," in which they tell their dealers the means that they have prepared to secure the buyers' attention. These include some printed matter; a book about padlocks, containing many suggestions for the uses of padlocks; a catalogue of the complete line of Yale & Towne padlocks; for those who do not care to read technical descriptions a story entitled "The Little Black Box" illustrating the merits of the Yale padlocks. Package labels, envelopes, etc., are also supplied. All of the above matter is given to the dealer free of charge and his name and address printed upon it.

THE AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, have just published a pamphlet, "Consolidation Type Freight Locomotive," which describes and illustrates a large number of the consolidation locomotives built by the company for various railways. The description includes only consolidation locomotives weighing less than 175,000 pounds; it will be followed shortly by a pamphlet illustrating locomotives of this type weighing more than 175,000 pounds. The present pamphlet opens with a description of the 2-8-0 type, giving its distinguishing characteristics and special advantages for heavy freight service, or service on light rails where the wheel load is limited. The principal dimensions of thirty consolidation locomotives ranging in weights from 66,000 to 175,000 pounds are given; the tables being arranged in order of weights. Side elevation and end elevation drawings of the typical design are shown and the remainder of the pamphlet is taken up with halftones of the thirty locomotives mentioned in the tables. This pamphlet is the third of a series to be issued by the company and which will include all the standard types of locomotives and constitute a record of its production. Copies of the pamphlet already issued on the Atlantic, Pacific and Consolidation types may be had upon request.

MANUFACTURERS' NOTES.

THE WHITMAN & BARNES MFG. CO., Chicago, Ill., announce the removal of their New York office from 111 Chambers Street to 59 Center Street.

THE WHITNEY MFG. CO., Hartford, Conn., are making unusual preparations for 1907, having in process new methods, new machinery, and a new modern fire-proof factory building.

THE JEFFREY MANUFACTURING CO., Columbus, Ohio, have established a new Canadian branch office in Montreal, Canada, at Lagauchetiere and Cotè Streets.

THE VON WYCK MACHINE TOOL CO., Cincinnati, O., lathe manufacturers, are erecting a large addition to their plant which will enable them to more than double their present output.

THE firm of Maris Bros., 56th Street and Gray's Avenue, Philadelphia, Pa., consisting of Frank Maris, Charles E. Maris, and M. B. M. Tatum, was dissolved October 1, 1906. The firm will be continued by Frank Maris and Charles R. Maris.

LATSHAW PRESSED STEEL AND PULLEY CO., Pittsburg, Pa., announce that they have appointed Henry J. McCoy Co. distributors for New York City, Chas. E. Ring & Co. for Brooklyn, R. Gray, Jr., Inc., for Newark.

THE F. H. BULTMAN CO. announce the purchase by them of the plant and business of Mr. F. H. Bultman. All correspondence, invoices, statements of accounts, etc., should be addressed to the company at 2108 Superior Avenue Viaduct, Cleveland, Ohio.

THE PATTERSON TOOL AND SUPPLY CO., Dayton, Ohio, on account of their growing trade in Indiana, have located their Mr. A. G. Schonacker at 508 E. Twenty-third Street, Indianapolis, and from this location are taking excellent care of their Indiana customers for machine tools and supplies.

L. H. GILMER & Co., Philadelphia, Pa., dealers in endless belting, machinery and supplies, announce that they have opened an office at 302 Mooney Building, Buffalo, N. Y., in charge of G. W. Gilmer, Jr.; also an agency in Glasgow, Scotland, 209 St. Vincent Street, in charge of Mr. Wm. F. Reid.

THE N. P. BOWSHER CO., South Bend, Ind., recently had a city fire alarm box installed on the ground between their factory and lumber yards. This, in connection with the district patrol service and private hydrants, gives the Bowsher Co. protection not excelled by any other factory in the city.

THE GISHOLT MACHINE CO., 1316 Washington Avenue, Madison, Wis., which acquired the plant of the American Turret Lathe Co., Warren, Pa., about a year and a half ago, are operating the plant, building their 30- and 36-inch boring mills there at present. The plant has been in operation for something over a year and is now employing about 125 men.

THE FOX MACHINE CO., Grand Rapids, Mich., report that their orders have for some time run far in excess of their capacity; this applies particularly to the Fox light milling machine. To keep up with their orders they have started a night crew, which together with the day work, means operating the shop twenty-two hours per day.

THE PATTERSON TOOL & SUPPLY CO., Dayton, Ohio, have sold their lathe manufacturing business to Chamberlin & Evinger. The purchasers have formed a company composed of H. T. Chamberlin, E. R. Evinger and W. D. Foster. The firm will be known as the Miami Valley Machine Tool Co. Ground has been broken for a new factory building which the firm hopes to occupy by January 1st. Meanwhile they are building lathes in the old shop.

THE HIDE & LEATHER ASSOCIATION OF NEW YORK CITY on Saturday, October 27, unveiled a historical tablet in the wall of the Schieren Building at Ferry & Cliff Streets, New York. A luncheon was served to invited guests at the conclusion of the ceremony. The district where this building is located was the birthplace of the leather and tanning industry of the city, and the leather business is still centered in this section.

THE STAR CORUNDUM WHEEL CO., Ltd., Detroit, Mich., have recently closed contracts for a new factory building which will be erected on Cavalry Avenue and Wabash R. R., Detroit, Mich. The building will be 70 x 175 feet and will be constructed of reinforced concrete and made fireproof throughout. Power will be furnished by a three-phase electric motor and the plant will be equipped with up-to-date machinery throughout for the manufacture of abrasive wheels. Their line includes principally solid corundum wheels, the vitrified, silicate and elastic processes being employed.

THE INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill., held its annual stockholders meeting September 10, 1906. Besides a new board of directors the following officers were elected for the ensuing year: James B. Brady, President; W. O. Jacquette, First Vice-President; J. D. Hurley, Second Vice-President; C. E. Erl son, Treasurer; A. B. Holmes, Secretary. The business of this firm has shown a phenomenal increase during the past year. The manufacturing plant is several months behind in its orders and a large increase in floor space of the factory has become necessary. A gratifying growth in the foreign demand has been reported.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, Ohio, announce the opening of a Chicago office in the Merchants' Loan and Trust Building, 135 Adams Street, Chicago, Ill., with Mr. W. M. Connelly in charge. Mr. Connelly was connected with the electrical department of the Homestead works of the Carnegie Steel Co. for five years and resigned his position there to become electrical engineer of the Ensley plant of the Tennessee Coal, Iron and Railroad Co. at Birmingham Ala., which position he held for three years and resigned to enter Central Station Work at Birmingham, Ala., and at Houston, Tex., where he organized and had charge of the sales department. Mr. Connelly enters upon his new duties fully equipped to take care of the interests of the Electric Controller & Supply Co. in the Chicago district.

THE STANDARD ROLLER BEARING CO., Philadelphia, Pa., have purchased the entire plant and real estate of the Pennsylvania Iron Works Co., which adjoins the present property of the Standard Roller Bearing Co. By this purchase the company have acquired five factory buildings with a total of 110,000 square feet floor space and a plot 120 x 1,600 feet, all located on the main line of the Pennsylvania Railroad. Two hundred and fifty thousand dollars was paid for the property. The Standard Roller Bearing Co. are at present erecting the largest reinforced concrete building in Philadelphia; it is five stories in height and 100 x 120 feet on the ground. This building will be devoted exclusively to the manufacture of annular ball bearings, automobile axles, etc. Over 1,200 people are now employed and this number will shortly be increased to 1,800. When the alterations are completed in the Pennsylvania Iron Works property it is expected that over 3,000 will be employed.

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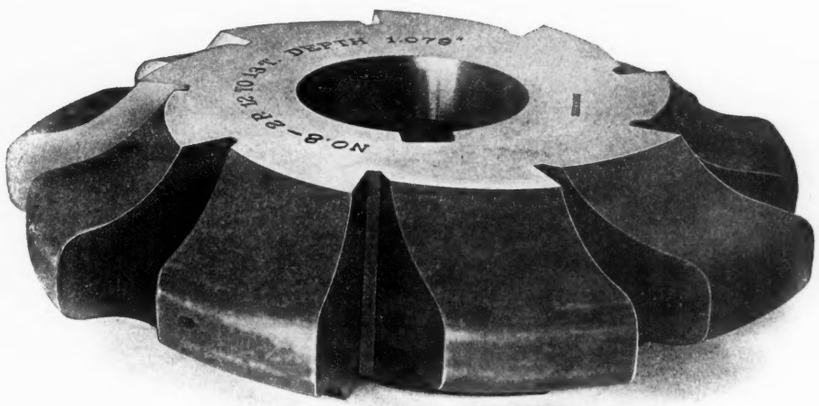

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The contents of the November number of the *Century* are a delightful blend of facts, fiction and theory. A noteworthy feature is the first installment of Mrs. Frances Hodgson Burnett's new serial—"The Shuttle," a story the opening chapters of which give promise of Mrs. Burnett's best work. Mr. Mason's strong story, "Running Water," is continued, the plot growing more tangled and our interest even more firmly enlisted. There are numerous short stories; an article on Whistler, the artist; an interesting study of Julia Marlowe with portrait in tint. The first of a series of papers by Ellis Paxson Oberholtzer which will particularly interest American business men appears in this number; it is entitled "Jay Cooke and the Financiering of the Civil War" and is illustrated by reproductions from daguerreotypes, paintings, etc. "Mr. Bryan and Our Complex Social Order" is the title of a paper by Franklin H. Giddings discussing the same subjects taken up in Mr. Bryan's Essay on Socialism which appeared in the *Century* of last April.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

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